Bridge Inspection Manual

Montana Department of Transportation

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The Montana Department of Transportation acknowledges the following organization and publication for some of the information utilized in the development of Chapter 5 of this Bridge Inspection Manual:

Connecticut Department of Transportation: *Bridge Inspection Manual*

CTDOT's Bridge Safety Inspection Manual is the intellectual property of the Connecticut Department of Transportation (CTDOT). The State of Montana is using this work with the express permission of CTDOT and acknowledges that it has no property interest in this Publication.

Chapter 1 – Program Organization

Chapter 2 – Qualifications of Personnel

Chapter 3 – Structure Inventory

Chapter 4 – Inspection Types and Intervals

Chapter 5 – Inspection Procedures

Chapter 6 – Conditions and Appraisals

Chapter 7 – Waterway Bridge Inspection

Chapter 8 — Agency Defined Elements

Chapter 9 – Record Keeping and Documentation

Chapter 10 – Review and Quality Assurance

Chapter 1 – Program Organization

Preface

i. Purpose

This March 2026 MDT Bridge Inspection Manual is an update to the May 2022 Bridge Inspection and Rating Manual. Note that the name has changed, now that a separate Load Rating Manual is being developed. This edition incorporates multiple changes in procedures and policies that have been established or revised since 2022 and updates to comply with the new *Specifications for the National Bridge Inventory* (SNBI).

This manual is intended to update, supplement and consolidate information regarding the evolving inspection and evaluation procedures for Montana's bridges. The new/revised content came from multiple MDT memoranda, new policies and new procedures. New content has either supplemented or replaced previous content and now also includes several BrM procedures that include screenshots to help guide BrM users through these procedures to improve data collection, coding and reporting.

The procedures and descriptions in this manual conform to American Association of State Highway and Transportation Officials (AASHTO) standards, Federal Highway Administration (FHWA) administrative rules and Montana Department of Transportation (MDT) policy. Discussion and the examples in this manual represent the most common bridge types in Montana.

If there is conflicting information or requirements between this manual and the SNBI, the SNBI will govern. Inspectors are not relieved from the responsibility of complying with the SNBI even when a conflict exists. If a conflict is discovered, notify the Bridge Inspection Engineer as soon as possible.

MDT uses a database management system software powered by AASHTOWare's Bridge Management software (BrM) to manage bridge data, track and report system-wide conditions, and perform analyses that support bridge funding decisions. The platform for this database changed over to AASHTOWare BrM in late 2021.

ii. Manual Format

This manual is formatted into chapters that cover major areas of inspection evaluation. Each chapter is divided into sections that cover specific issues and needs.

Chapter 1 – Program Organization

Chapter 1 provides a brief background and overview of the bridge inspection program and the five primary responsibilities of the program. On-System, Off System, Major Structures and Minor Structures are defined. The functions and responsibilities of the Bridge Management Section and District Offices are listed. A single Chapter 1 appendix provides a flowchart for minor inspection needs.

Chapter 2 – Qualifications of Personnel

Chapter 2 provides MDT's qualifications for state and consultant inspection personnel, including dive and NDT personnel. This chapter also outlines requirements for continuing education and training, including how this continuing education/training history is documented and recorded.

Chapter 3 – Structure Inventory

Chapter 3 provides MDT's guidance on bridges to include in the MDT inventory, bridge numbering, inventory direction, and bridge nomenclature. It also includes guidance for measuring, documenting and coding clearance measurements, as well as clearance posting requirements. Chapter 3 also includes MDT-specific guidance for coding traffic safety features, span/structure lengths, and load-posting inventory items. There is also discussion on measurement forms, note-taking, and bridge correspondence. Chapter 3 appendices provide roadway clearance templates and railroad clearance templates.

Chapter 4 – Inspection Types and Intervals

Chapter 4 provides guidance for the various types of inspections performed for MDT structures. This guidance includes inspection frequencies, inspection data collection, inspection planning, and when the various inspection types are required. Inspection types include initial/inventory, routine, underwater, NSTM, damage, non-fracture steel bridge hands-on, as well as other/special inspections including pin & hanger/NDT inspections. This chapter also includes guidance for complex bridge inspections, consultant inspections, and alternative access inspections including climbing and unmanned aerial systems (UAS) inspections. Chapter 4 appendices include several special/damage inspection forms, extended inspection interval guidance, NBI/MDT inventory item responsibility tables and climbing bridge guidance.

Chapter 5 – Inspection Procedures

Chapter 5 provides guidance on Critical Finding procedures and inspection procedures for the deck, superstructure and substructure various material types and the elements that they are comprised of. Inspection procedures detail the inspection and documentation requirements, a summary of report review requirements in accordance with established QC/QA procedures and guidance on inspector recommended maintenance considerations. This chapter also includes an overview of the mechanics of bridges and fatigue prone details along with identification of the various types of trusses.

Chapter 6 – Condition and Appraisal

Chapter 6 begins with a discussion of both NBI Inspections and Element Level Inspections. The Element Level Inspection discussion is robust and includes element identification, element defect codes/rating, and element environment coding. MDT-specific inventory items are defined and proper coding is discussed. This chapter also includes guidance for condition coding for repaired bridge components, as well as sistered girder guidance. Chapter 6 appendices include jump crack guidance, and a guide for assisting in the calculation of bridge rail protective coating quantities.

Chapter 7 – Waterway Bridge Inspection

Chapter 7 starts with the purpose of and criteria to qualify a bridge for different types of waterway inspection. It also discusses the difference between Probe & Wade and Underwater inspections, procedures and techniques. This Chapter concludes with required waterway photos and an Appendix 7A, which provides guidance on entering stream cross section data into BrM.

Chapter 8 – Agency Defined Elements

Chapter 8 contents include all current MDT Agency Defined Elements (ADEs). ADEs are provided in standard MBEI coding table format for use in identifying and condition state coding of all relevant Agency Defined Elements for each bridge.

Chapter 9 – Record Keeping and Documentation

Chapter 9 provides guidance for pre-inspection bridge review, defect note-taking, photo documentation and uploading correspondence and bridge-related documents to BrM. This discussion is followed by guidance for inspection report draft generation in BrM, QC review of the inspection report draft and finalization of the inspection reports. Significant change/problem reporting requirements and guidance for adding repair suggestions is included in this chapter. Chapter 9 appendices include guidance for climbing bridge inspection reporting and a field inspection QC checklist.

Chapter 10 – Review and Q&A

Chapter 10 provides responsibilities and requirements for Quality Control / Quality Assurance performed by Districts and by the Bridge Management Section in Headquarters. Space is reserved in this section for an updated Quality Assurance Program to be added at a later date.

iii. Revisions

This manual will be updated to incorporate periodic revisions based on the practices outlined by FHWA, AASHTO, and MDT. The Bridge Management Section will review Montana bridge inspection practices and procedures for compliance with the Code of Federal Regulations (Title 23 CFR 650.3), AASHTO Manual for Bridge Element Inspection (MBEI), and FHWA Recording and Coding Guide for Structure Inventory and Appraisal of the Nation's Bridges. In addition, the Bridge Management Section will review comments from the MDT inspection community. We encourage users to submit any errors, recommendations, or revisions to the Bridge Management Section.

vi. Abbreviations and Acronyms

Manuals/Standards and Terminology	
Abbreviation/Acronym	**Measurement**
ADE	Agency Defined Element
ADT	Average Daily Traffic
ADTT	Average Daily Truck Traffic
ANSI	American National Standards Institute
ArcGIS	A software which provides Geographic Information System services
ASNT	American Society for Nondestructive Testing
AWS	American Welding Society
BF	Both Faces or Bottom Flange (depending on context)
BIM	Bridge Inspection Manual
BIRM (MDT)	Bridge Inspection and Rating Manual (no longer used)
BIRM (FHWA)	Bridge Inspector's Reference Manual
BLM	Bureau of Land Management
BME	Bridge Management Element
CoRE	Commonly Recognized Structural Elements (AASHTO)
CTDOT	Connecticut Department of Transportation
DBIC	District Bridge Inspection Coordinator
DMS	Degrees Minutes Seconds
DT	Destructive Testing
EV	Emergency Vehicle
FAA	Federal Aviation Administration
FF	Far Face
FHWA	Federal Highway Administration
FRP	Fiberglass Reinforced Polymer
FSD	Fatigue Sensitive Detail
GRS-IBS	Geosynthetic Reinforced Soil-Integrated Bridge Systems
GVW	Gross Vehicle Weight
IIW	International Institute of Welding
IRATA	Industrial Rope Access Trade Association
LRFR	Load and Resistance Factor Rating
LRS	Linear Referencing System
MBE	Manual for Bridge Evaluation (AASHTO)
MBEI	Manual for Bridge Element Inspection (AASHTO)
MBS	Minimum Breaking Strength
MDT	Montana Department of Transportation
MDTID	Montana Identification
MHP	Montana Highway Patrol
MPO	Metropolitan Planning Organization
MT	Magnetic Particle Testing or Montana (depending on context)
MDTID	Montana Identification

Manuals/Standards and Terminology	
Abbreviation/Acronym	**Measurement**
MUTCD	Manual for Uniform Traffic Control Devices
NBE	National Bridge Element
NBI	National Bridge Inventory
NBIS	National Bridge Inspection Standards
NCHRP	National Cooperative Highway Research Program
NDT	Non-Destructive Testing
NF	Near Face
NHI	National Highway Institute
NHS	National Highway System
NSTM	Nonredundant Steel Tension Member
OSHA	Occupational Safety and Health Administration
P&H	Pin and Hanger
P/S	Prestressed
PPE	Personal Protective Equipment
QA	Quality Assurance
QC	Quality Control
RC	Reinforced Concrete
SHV	Specialized Hauling Vehicle
SIP	Stay-In-Place
BrM	AASHTOWare Bridge Management
SNBI	Specification for National Bridge Inspection
SPRAT	Society of Professional Rope Access Technicians
SR	Sufficiency Rating
STRAHNET	Strategic Highway Network
TE	Transporter Erector
TL	Team Leader
UAS	Unmanned Aerial System(s)
UBIV	Under-bridge Inspection Vehicle
UPN	Uniform Project Number
USDA	U.S. Department of Agriculture

Units of Measure	
Abbreviation/Acronym	**Measurement**
AVE	Average
CL	Centerline
DEG	Degree
DP	Deep/Depth
FD	Full Depth
FH	Full Height
FL	Full Length
FT	Foot or Feet
FW	Full Width
H	High
HZ	Horizontal
IN	Inch
L	Long/Length
LAT	Lateral
LF	Linear Feet
LONG'L	Longitudinal
MAX	Maximum
MEAS'D	Measured
MIN	Minimum
MSMT	Measurement
SQIN	Square Inch
TV	Transverse
VT	Vertical
W	Wide/Width

Field Note Defects	
Abbreviation/Acronym	**Defect**
AGG	Aggradation or Aggregate (depends on context)
AL	Active Leakage (typically joint related)
AR	Abrasion Rust (typically at connections)
BOT	Bottom
CHK	Check
COND	Condition
CR	Crack
CS	Condition State (generic, without a numerical association)
CS-1,CS-2,CS-3,CS-4	Condition State 1,2,3,4
DAM	Damage
DELAM	Delamination
DET	Deteriorated/Deterioration
EFFLO	Efflorescence
ENV	Environment
EXP	Exposed or Expansion (depends on context)
HA	Hollow Area (hollow sounding but no perimeter cracks)
HLCR	Hairline Crack
HVY	Heavy
IMP DAM	Impact Damage
INSP	Inspection, Inspect, Inspected
LAM	Laminated
LR	Laminated Rust
LT	Light or Left (depends on context)
MATL	Material
MOD	Moderate
MPCR	Map Crack
PERF	Perforation
PH	Pothole
PP	Peeling Paint
PROT	Protective/ Protection (as in protective coating or scour protections)
PTT	Pitting
REP/REP'D	Repair/ Repaired
RT	Right
RTH	Rusted through hole
SC	Scale
SEV	Severe
SL	Section Loss

Field Note Defects	
Abbreviation/Acronym	**Defect**
SP	Spall
SR	Surface Rust
SURF	Surface
TYP	Typical
W/	With….

Materials	
Abbreviation/Acronym	**Material**
AL	Aluminum
BIT	Bituminous
CONC	Concrete
GALV	Galvanized
MAS	Masonry
P/S	Prestressed
P/T	Post Tensioned
RC	Reinforced Concrete
STL	Steel

Bridge/Roadway/Channel Notes	
Abbreviation/Acronym	**Name**
AB	Anchor Bolt
ABUT	Abutment
AOL	Ahead on Line (Upstation)
APPR	Approach
BF	BF Flange
BOL	Back on Line (Downstation)
BR	Bridge
BRG	Bearing
CMP	Corrugated Metal Pipe
COL	Column
CONN	Connection
D/S	Downstream
DIAPH	Diaphragm
DWL	Dashed White Line or Double White Line (rare)
DWNSTA	Downstation
DYL	Double or Dashed Yellow Line
EB	Eastbound
ED	End Diaphragm
ELAST	Elastomeric

Bridge/Roadway/Channel Notes	
Abbreviation/Acronym	**Name**
EMBK	Embankment
ET	End Treatment (guide rail end)
FB	Floorbeam
FLG	Flange
FTG	Footing
GIRD or G	Girder
GP	Gusset Plate
GR	Guardrail
HWY	Highway
LL	Live Load
LN	Lane
MT##	Montana State Highway (i.e. MT40 = Montana State Highway 40)
NB	Northbound
O/LAY	Overlay
P&H	Pin & Hanger
PED	Pedestal
PL	Plate
PPT	Parapet
RCP	Reinforced Concrete Pipe
RDWY	Roadway
RET	Retaining (Wall)
RR	Railroad
SB	Southbound
SIP	Stay-in-Place (formwork)
STIFF	Stiffener
STR	Stringer
SUB	Substructure
SUPER	Superstructure
SWL	Solid White Line
SYL	Single Yellow Line
TF	Top Flange
U/S	Upstream
UPSTA	Upstation
WB	Westbound
WL	Water Line
WS	Wearing Surface
WW	Wingwall

Chapter 1 provides a brief background and overview of the bridge inspection program and the five primary responsibilities of the program. The functions and responsibilities of the Bridge Management Section and District Offices are listed.

1.1 Background

During the highway expansion of the 1950s and 1960s, inspection and maintenance of bridges was not considered a high priority. After the collapse of the Silver Bridge in Point Pleasant, West Virginia in 1967, a National Bridge Inspection program was developed. This program emphasized inspection frequency, inspector qualifications, reporting format, and inspection and rating procedures. Several other bridge failures established the need for the expansion of the national program to include culverts and underwater and nonredundant steel tension member components. In the mid-1990s, there was a movement to evaluate individual components of a bridge utilizing the AASHTO Guide for Commonly Recognized Structural Elements (CoRE), published in 1998. AASHTO revised the CoRE Manual in 2013 to the *Manual for Bridge Element Inspection* (MBEI) and updated the publication in 2015 and 2019 to revise Condition States and eliminate Smart Flag language.

This Bridge Inspection Manual is based on the latest AASHTO *Manual for Bridge Element Inspection* and FHWA's *Specifications for the National Bridge Inventory*.

1.2 Overview

The MDT Bridge Inspection Program is administered by the Bridge Management Section of the Bridge Bureau and operates under the auspices of the Federal Highway Administration (FHWA) in accordance with National Bridge Inspection Standards (NBIS). The five primary responsibilities of the Bridge inspection program are:

- Maintain Public Safety and Confidence (Structural Concerns)
- Protect Public Investment (Maintenance Concerns)
- Maintain a Desired Level of Service (Functionality Concerns)
- Provide Accurate Bridge Records
- Fulfill Legal Responsibilities (Comply with the Code of Federal Regulations)

MDT is responsible for the inspection of both state-owned and locally owned bridges within the state. State owned bridges include those owned and maintained by state agencies other than MDT. Approximately five thousand bridges are inspected by MDT with almost 60% owned and operated by MDT.

MDT is broken into five regional districts. Each of the five districts has an inspection team that is responsible for the inspection of bridges within their Area designation. Area designations do not strictly follow district boundaries.

1.3 Inspection Program Functions

The bridge inspection program includes condition inspection of bridges. This Manual focuses only on condition inspection of bridges. See MDT's *Bridge Load Rating Manual* for information on load rating policies and procedures.

The Code of Federal Regulations requires each state department of transportation to inspect, or cause to be inspected, all highway bridges on public roads that are fully or partially located within the state's boundaries, with the exception of federally or tribally owned bridges, and maintain a comprehensive bridge inventory, performing regular safety evaluations, and overseeing repairs. Each state must have a bridge inspection organization capable of ensuring that required inspections are performed, which includes completing required reports and maintaining inventory records. In Montana, this responsibility falls under the Bridge Management Section located at MDT Headquarters with inspectors located throughout the state.

1.3.1 Bridge Management Section

The Bridge Management Section is responsible for the overall bridge inspection program and is a part of the Bridge Bureau in Headquarters. The section consists of engineers and technicians who provide direction and support to the program. The primary functions and responsibilities are listed below.

- Bridge Inspection Program Management
    - Asset management
    - Information management for Planning
    - Coordination with FHWA
    - In-house bridge inspections
    - Consultant bridge inspections
    - Technical support for bridge inspectors
    - Bridge inspection inventory management (BrM)
    - Bridge inspection QA/QC
    - Bridge inspection team leader certification
    - Bridge inspection policies and procedures
- Bridge Load Rating Program Management
    - Asset management
    - Information management for Planning
    - Coordination with FHWA
    - In-house bridge load ratings
    - Consultant bridge load ratings
    - Load rating inventory management (BrM)
    - Bridge posting and restriction
    - Technical support for bridge inspectors
    - Bridge overweight permitting
        - In-house permitting analysis
        - Consultant permitting analysis

        - Technical support for Motor Carrier Services
- Bridge Maintenance Program Management
    - Asset management
    - Information management for Planning
    - Coordination with FHWA
    - In-house bridge maintenance
    - Contracted bridge maintenance
    - Technical support for district Maintenance crews
    - Technical support for bridge inspectors

1.3.2 Area Bridge Inspection Offices

Each Area office is responsible for inspecting bridges within its Area. The primary functions and responsibilities of these offices are described below.

- Bridge Inspection
    - Regional program management
    - In-house bridge inspections, including inspection equipment and resource planning and scheduling
    - Coordination with the Bridge Management Section, counties, cities, railroads and other entities as required to perform bridge inspections
    - Inspector safety management
    - Inspection data entry and validation
    - Inspection quality control

1.3.3 Key Inspection Personnel and Qualifications

The number of inspectors per region varies depending on inspection needs; however, there are a minimum of two positions in each district that are dedicated to bridge inspection.

District Bridge Inspection Manager

The District Bridge Inspection Manager position is a full-time bridge inspection position responsible for inspection compliance at the Area level. Duties of the position include managing the Area’s bridge inspectors, scheduling inspection activities, training bridge inspectors, performing Quality Control checks on Area inspections, and inspecting bridges. MDT requires this person to be a qualified Team Leader for routine inspections.

Bridge Inspection Team Leader 2

The Team Leader 2 position is a full-time bridge inspection position that helps the District Bridge Inspection Manager with bridge inspection planning, inspector training, inspection coordination, bridge inspection quality control. This position also leads bridge inspection crews on Nonredundant Steel

Tension Member (NSTM) inspections and other complicated inspections that require additional experience. MDT requires this person to be a qualified Team Leader for routine and NSTM inspections.

1.3.3.1 Inspection Crew

An inspection crew includes all bridge inspection team leaders and bridge inspection trainees who work under the District Bridge Inspection Manager. The crew is responsible for performing field inspections and entering inspection data into BrM, along with other duties as assigned.

Chapter 2 – Qualifications of Personnel

Chapter 2 describes MDT's qualification requirements for state and consultant inspection personnel, including divers and Non-Destructive Testing (NDT) personnel. This chapter also outlines requirements for continuing education and training of inspectors, including how continuing education and training history is documented.

2.1 Bridge Inspection Program Manager Qualifications

MDT's bridge inspection program manager, also known as the Bridge Inspection Engineer, must meet the following requirements:

- Be a registered Professional Engineer in the state of Montana
- Complete an FHWA-approved comprehensive bridge inspection training course as required per federal regulations.
- Have at least eight years of experience in a combination of in-service bridge inspection and in-service bridge inspection oversight.

2.2 Consultant Project Manager Qualifications

Must be a registered Professional Engineer in Montana, have five years of bridge inspection and/or load rating experience, and have successfully completed an FHWA-approved comprehensive bridge inspection training course. They must also successfully complete FHWA-approved bridge inspection refresher training every five years.

2.3 Area Bridge Inspection Manager Qualifications

- A minimum of two years of Team Leader experience in inspection of in-service bridges.
- A minimum of one year of supervision or leadership experience.
- Qualification as a Team Leader also requires any one of the following:
    - Five years of experience with in-service bridge inspection and successful completion of an FHWA-approved comprehensive bridge inspection course. A portion – up to but not more than two and a half years - of the experience required to satisfy this requirement may be obtained through participation in construction inspection activities on bridge construction projects.
    - A Professional Engineering license in the State of Montana, one year of experience with in-service bridge inspection, and successful completion of an FHWA-approved comprehensive bridge inspection course.
    - A bachelor's degree in Civil Engineering or Construction Engineering Technology from a college or university accredited by or determined as substantially equivalent by the Accreditation Board for Engineering and Technology (ABET), a current Engineer Intern license from the Montana Board of Professional Engineers and Professional Land Surveyors, two years of in-service bridge inspection experience, and successful completion of an FHWA approved comprehensive bridge inspection course.

2.4 Team Leader Qualifications

Qualification as a Team Leader requires any one of the following:

- Five years of experience with in-service bridge inspection and successful completion of an FHWA-approved comprehensive bridge inspection course. A portion – up to but not more than two and a half years - of the experience required to satisfy this requirement may be obtained through participation in construction inspection activities on bridge construction projects.

- A Professional Engineering license in the State of Montana, one year of experience with in-service bridge inspection, and successful completion of an FHWA-approved comprehensive bridge inspection course.
- A bachelor's degree in Civil Engineering or Construction Engineering Technology from a college or university accredited by or determined as substantially equivalent by the Accreditation Board for Engineering and Technology (ABET), a current Engineer Intern license from the Montana Board of Professional Engineers and Professional Land Surveyors, two years of in-service bridge inspection experience, and successful completion of an FHWA approved comprehensive bridge inspection course.

2.5 NDT Inspector Qualifications

NDT inspector certifications will be current and meet the minimum industry and manufacturer requirements for the materials and tests being performed. Ultrasonic testing must be performed by an American Society for Nondestructive Testing (ASNT) NDT Level II inspector.

2.6 Inspection Assistant Qualifications

There are no minimum requirements for education, certification, or technical knowledge of inspection assistants, but they must be able to physically assist a Team Leader in the inspection of bridges. Inspection assistants are preferably trainees working towards their Team Leader qualification as required in Section 2.4.

2.7 Underwater Bridge Inspection Diver Qualifications

All divers performing underwater bridge inspections are required to successfully complete an FHWA-approved underwater bridge inspection diver training course. All diving personnel will be trained in accordance with 29 CFR Part 1910, Subpart T, Commercial Diving Operations; Occupational Safety and Health Administration Standards (OSHA).

Divers who are not acting as Team Leaders are not required to complete refresher training.

2.8 NSTM Team Leader Qualifications

Nonredundant Steel Tension Member (NSTM) Team Leaders must meet all requirements of a Bridge Inspection Team Leader in addition to successfully completing an FHWA-approved NSTM training course.

2.9 Special Inspection Qualifications

Inspectors performing special inspections must meet all requirements of a Bridge Inspection Team Leader.

2.10 Damage Inspection Qualifications

Inspectors performing Damage inspections must meet all requirements of a Bridge Inspection Team Leader.

2.11 Continuing Education Requirements

Federal law requires all bridge inspectors to complete a total of 18 hours of FHWA-approved bridge inspection refresher training every five years.

Inspectors who do not meet continuing education requirements will be disqualified and no longer allowed to inspect bridges for MDT until they complete additional training as required by the Bridge Inspection Engineer. The type and amount of training will be decided on a case-by-case basis.

2.11.1 MDT Inspectors

In addition to federal requirements, MDT requires inspectors to complete one of the following training options every two years:

- Attend at least eight hours of a field Quality Assurance Review
- Attend the entire Bridge Inspectors' Workshop

If one of these requirements is not met, MDT may accept other bridge inspection training on a case-by-case basis.

2.11.2 Consultant Inspection Requirements and Inspector Training

In addition to federal requirements, consultants inspecting bridges for MDT must complete at least eight hours of continuing education training related to bridge inspection every two years. This continuing education requirement can be met under the requirements for MDT inspectors or can be met through attendance at any FHWA-approved course related to bridge inspection. Attendance at bridge inspection conferences is also acceptable training. Other training may be evaluated and accepted by MDT on a case-by-case basis. Proof of training, including hours, is the responsibility of each inspector.

2.12 Bridge Inspector Training

2.12.1 NHI Courses

National Highway Institute (NHI) or other FHWA-approved courses will be brought to MDT for inspector training on a rotating basis or as needed.

2.13 Bridge Inspectors' Meeting

MDT's Bridge Management Section provides quarterly training meetings for inspectors that last approximately two hours. In addition, MDT provides annual training meetings lasting eight hours. Topics discussed during these meetings may include any updates/changes in bridge inspection/reporting procedures/BIRM, results of QA reviews, lessons learned from QA reviews, industry updates, and open discussion about the bridge inspection program.

2.13.1 Additional Training as Needed

Additional bridge inspector training is provided on an as-needed basis for topics that must be addressed prior to the regular meetings discussed in Section 2.13. Annual Underbridge Inspection Vehicle (UBIV) training is also required for inspectors who operate UBIVs. Railroad Safety Training is required for any inspector who works on railroad rights-of-way.

2.14 Inspector Training and Experience Records

2.14.1 Bridge Management Section

The Bridge Management Section keeps records of classes taken by all inspectors and inspection trainees, and of the time inspectors have spent on QA reviews or attending the Bridge Inspectors' Meeting, as required.

2.14.2 Inspectors

Inspectors are responsible for uploading their training certificates to MDT's BrM System and keeping their certification documentation current. Contact the Bridge Inspection Engineer or designee for instructions on uploading training documents. This includes tracking of time spent on a QA review or attending the Bridge Inspectors' meeting.

An inspection trainee is responsible for tracking their inspection time and ensuring that the proper forms are completed. Trainee experience forms are found on the MDT bridge inspection website and must be signed by the Team Leader with whom the trainee is working when gaining inspection experience.

Chapter 3– Structure Inventory

3.1 General

There is a list of acronyms in Chapter 1 for reference.

3.2 Purpose – Introduction

The importance of proper inspection and documentation for bridge safety inspection cannot be overstated. The introduction and implementation of Element-Level Inspection requires a more granular defect inspection and documentation. The resulting data and report information is critical for ensuring the safety of the traveling public and for asset management and investment decisions to maintain and protect our infrastructure. Therefore, the goal and purpose of this chapter is to clarify and describe in detail the various procedures, methods and requirements for inspection and documentation for all portions of a bridge in Montana. It also provides forms and templates to be used for documentation.

Federal regulations require each bridge inspection organization to prepare and maintain an inventory of all bridges for which they are responsible. The bridge inventory provides certain standard information about each bridge and is updated throughout the bridge's life until it is no longer in-service.

AASHTOWare Bridge Management (BrM) contains fields required by Specifications for the National Bridge Inventory (SNBI) as well as additional MDT-defined fields to manage the bridge inventory. The SNBI information is transmitted to the Federal Highway Administration (FHWA) yearly to update the National Bridge Inventory (NBI) Database.

3.3 Types of Structures

There are three main types of structures in MDT's inventory:

1. Major structures meet the requirements to be considered a bridge and are reported as part of the National Bridge Inventory (NBI)
2. Minor structures are inspected by MDT for safety reasons, but do not qualify for the NBI
3. Non-SNBI overhead structures do not carry traffic loads but cause height restrictions over major highways and can be safety hazards if they deteriorate to the point where material falls off of them. Not all overhead structures are inventoried. See 3.3.3 for more information.

A flowchart to help in determining whether a structure is major, minor, or overhead can be found in Appendix 3D.

3.3.1 Major Structures

A major structure is defined as a structure, including supports, erected over a depression or an obstruction, such as a waterway, highway, or railway, and must have the following features:

A track or passageway for carrying traffic or other moving loads.

An opening measured along the center of the roadway of more than 20 feet between under coping of abutments, spring lines of arches, or extreme ends of openings for multiple boxes.

- The 20 ft measurement may also include multiple culvert pipes, where the clear distance between openings is less than half the smaller contiguous opening.

3.3.2 Minor Structures

Some structures not meeting major qualification still require inspection either due to FHWA exceptions or because of MDT requirements. On National and State Highway systems, the inspection of bridges down to 8 feet in length is desirable. Buried structures are to be treated as culverts and need not be inspected unless they carry a critical facility (TE Routes) or qualify under major structure guidelines.

This means that we inspect bridges down to 8 feet in span length on all state owned and maintained. This includes the following:

Primaries
NHS routes
Urban Routes
State-Maintained Locals (Frontage Roads, or X Routes)
Interstates
State Maintained Secondaries (Beginning in 2030)

MDT does not inspect bridges down to 8 feet in span length on county-maintained local routes, local urban routes, municipal bridges, or bridges on county-maintained Secondary Routes, regardless of whether they are state or county-maintained.

Buried structures are those buried under a depth of fill equal to or greater than ¼ of the span length. Buried structures do not need to be inspected unless they carry a critical facility. Interstates and TE Routes are critical facilities. All box or buried structures with a single span of at least 8 feet on critical routes are to be inspected. Any single box or buried structure, or individual units of multiple buried structures meeting the definition of a Minor Structure, with an opening width less than 8 feet do not need to be inspected. For example, two independent 6-foot culverts that are side-by-side add up to a span of more than 8 feet, but no single span is over 8 feet, so they do not need to be inspected. See Appendix 3D for a flowchart to help with classifying structure types.

3.3.3 Overhead Structures

Overhead structures are typically railroad, selected pedestrian or wildlife structures that cross over a major MDT highway. These structures are inventoried for safety reasons, both for height restrictions and the safety of traffic traveling below the structures. Inspection of these structures is the responsibility of other agencies, but MDT typically performs substructure inspections on these bridges to help us stay informed of any safety issues. Overhead structures are only inventoried if they cross over interstate, primary or urban routes.

Enclosed pedestrian structures with no visible bridge components typically do not require inspections to be performed. Inspections are not performed on this type of structure because there are no bridge parts to inspect. Roadway clearances are rechecked periodically.

3.4 Bridge Numbering, Inventory Direction and Nomenclature

3.4.1 Bridge Numbering

MDT’s bridge IDs have an interesting history, which is fully explained in Appendix 3C. At the time this manual is being written, each structure has two main identifiers: its National Bridge Inventory Identification (NBI ID) and its MDT Identification (MDTID). The MDTID is an agency-assigned identification number that indicates the spatial location of a structure crossing. The NBI structure ID is the official identification number that is reported to FHWA. Once an NBI ID is assigned, it will never change over the life of the bridge. A structure that replaces another in the same location will have the same MDTID as the old structure, but will have a unique NBI ID. New NBI IDs are assigned based on the year the ID is assigned and the MDTID. The year in the NBI ID is not necessarily the year the bridge was built because the ID could have been assigned for the plans before construction, or a bridge might be added to the inventory many years after it was constructed.

Structure IDs are assigned by the Bridge Inspection Program Manager or their designee. Federal and state requirements for these IDs are listed below.

Federal Requirements

The National Bridge Inventory (NBI) has the following requirements:

- Structure numbers must be unique.
- An official structure number must be recorded for all highway bridges twenty feet or greater in length (major structures).
- Structures with closed medians will be considered one structure.

State Requirements

After 2015, Montana established a bridge numbering system to be used for NBI IDs going forward for all new bridges. Note that existing bridges have a different numbering system, which will remain in place until those bridges are replaced.

An official, unique NBI structure number is recorded for all inspectable structures that impact the traveling public, as follows:

- All major and minor structures are given an NBI ID even though minor structures are not reported to FHWA. This allows MDT to keep track of which version of the bridge belongs to the MDTID.
- All structures have an MDTID.
- Structures new to the inventory will be assigned a new MDTID
- See Appendix 3C for a history on MDT's NBI IDs and the MDTID
- New NBI IDs will follow this format: YEARMDTID (example: 202601234) where YEAR denotes the year the asset ID was assigned. This may or may not match the year the structure was constructed. Some NBI IDs are assigned while a structure is in the planning stages so the new ID can be put on the bridge plans. In these cases, the year may be a few years before the bridge is constructed.
- New NBI IDs will be assigned by the Bridge Inspection Program Manager or designee.

3.4.2 Bridge Inventory Direction

This section addresses how to code or establish the Inventory (or log) direction of the route carried by the structure following a priority list. Most structures (with previous inspections) will be addressed by the first priority below.

1st Priority: Bridge inventory direction that has been used in previous inspections will be perpetuated forward. This will be done even if the bridge has been inspected using an unconventional bridge inventory direction in the past. If a bridge has been inspected using an unconventional bridge inventory direction in the past, add a note in the general bridge notes using the nomenclature guidance below and update the Bridge Inventory Direction attribute in BrM.

2nd Priority: For routes with mile posts, bridge inventory direction is defined in order of increasing mile post or stationing. For example, if mile post 1 is South of the bridge and mile post 2 is North of the bridge, bridge inventory direction would be oriented from South to North.

3rd Priority: For routes with no obvious defined stationing, bridge inventory direction will be assigned using the direction on the plans. When plans are not available, stationing will be assigned using the inspector’s best judgment but will generally be oriented from South to North or West to East.

Enter a description of the bridge inventory direction in the inspection notes for **every** inspection using the nomenclature below. Once bridge inventory direction is determined, if not already defined, select the appropriate direction from the drop-down box in the BrM attribute named Bridge Inventory Direction (MDT145) located in the Inventory/appraisal, Identification tab.

3.4.3 Bridge Nomenclature

Once bridge inventory direction is defined at a bridge, use nomenclature such as “North,” “East,” etc. to describe which direction the bridge is being inventoried in. In addition, terms such as “upstream” and “downstream” may be used to describe the orientation relative to features crossed or features near the structure (utilities, erosion, approaches, etc.). This is especially important to clarify when a new bridge is being inventoried, at any time that there has been a change in bridge inventory direction in the past, or when the bridge inventory direction conflicts with as-builts.

Once bridge inventory direction has been established and defined, bridge elements will be defined in the following manner:

Bridge bents will be numbered starting with Abutment 1, then moving up the inventory direction to subsequent bents (i.e., Abutment 1, Pier 2, Pier 3, Abutment 4. The only time the pier nomenclature would not be used is in the case of tower abutments. The other side of the tower abutment would be Bent 2 instead of Pier 2 (example: a five-span bridge with tower spans at both ends would be numbered Abutment 1, Bent 2, Pier 3, Bent 4, Abutment 5).

Substructure units (abutments and piers) will have their number/label written with Sharpie or paint stick near their centerlines by inspectors (i.e., A1, B2, B3, etc.).

Bridge elements (girder, piles, etc.) are numbered looking in the direction of the inventory (starting at Abutment 1 looking to subsequent bents).

Numbering is done from left to right, starting with #1 (Pile 1 and Girder 1 are the left-most element, then Pile 2, Pile 3, etc.).

Never refer to elements starting from the right (i.e., second girder from the right).

Piles that do not directly carry load from the superstructure (wingwalls, return walls, etc.) will not be counted.

Girder spans with sister girders (most common with timber) will have the following naming convention: The original girder number will always remain the same; however, the sister girder will have a name corresponding to the original girder number and the side (right or left) the sister girder is on. For example, if the original Girder 7 has a sister girder on the right, the sister girder will have the name G7R. The sister girder will have this name regardless of the condition of the original timber girder and whether the original girder is included in the element quantities. Right and left denotations are determined when looking in the direction of the bridge inventory direction.

For trusses, the bottom chord nodes will be labeled L0, L1, L2, L3, etc. all the way to the other end. The upper chord nodes should match the number of the bottom chord node directly below it, but be labeled U1, U2, U3, etc. Middle nodes on the trusses that have them will be numbered similar to the upper chord but start with M (M3, M4, M5 etc.). See Chapter 5 for examples of truss labeling conventions.

3.5 Measuring Clearances and Standard Clearance Forms

Measure bridge clearances as required in the SNBI. Forms to help in measuring bridge clearances are available in the appendix.

Clearance signs at bridges may not match inspector measurements. There are a couple reasons for this. One reason is that 6 inches is typically subtracted off actual measurements for safety reasons and for a buffer in case the roadway underneath gets an overlay. If your clearance measurements are less than the measurements on the posted sign, notify the local agency responsible for the signs. This may be a county or local Maintenance Superintendent. Make sure your notification is in writing (an email is fine) and uploaded to BrM.

3.5.1 Clearances and Safety Inspection for Railroad Bridges over Roadways

Railroad or pedestrian bridges that cross over an MDT owned or maintained route must be entered into BrM and must have clearance measurements. A full inspection is not required unless the crossing structure is owned by MDT. In addition to taking and documenting clearances, the inspection team must inspect for any other conditions that could impact the safety of the roadway and vehicles or pedestrians below. Examples include but are not limited to any loose overhead components or materials (i.e. signage, ice, utilities, concrete, steel, ballast and/or track components if open track) or defects or signs of distress impacting the structural capacity of main load carrying members.

3.6 Railing Coding

3.6.1 Bridge Rail (B.RH.01)

In Montana, our bridges have rails with several different crash test levels. For the purpose of this version of the manual, only railing that is part of the MDT standard drawings will be covered. Counties may or may not have their own standards for bridge rail. New guidance and updates to this manual will become available as MDT headquarters continues to research bridge rail in the state.

MDT Standard Bridge Rail meeting MASH crash test requirements is listed below.

Single Slope 36” Concrete Barrier - MDT standard drawings SBR-SS36 and SBR-SS36R. While this bridge rail is very similar to the single slope barrier crash tested by TxDOT, it is not identical. This means that it has not been crash tested but was designed to meet MASH standards. Code B.RH.01 as S19. 2019 is the year the new bridge rail guidance was released.

Single Slope 42” Concrete Barrier – MDT standard drawings SBR-SS42 and SBR-SS42R. This rail has not been crash tested, but it was designed to meet MASH test level standards. Code B.RH.01 as S19.

Open Bridge Rail 42” - MDT Bridge standard drawings SBR-OR42, SBR-OR42PP. Note that there is an option with picket panels, which is shown in MDT Bridge standard drawing SBR-OR42-PK. This rail meets MASH test level 5 standards, and was crash tested in 2021. Code B.RH.01 as M215.

MDT Standard Bridge Rail meeting NCHRP 350 crash test requirements are listed below. Please note that these rails do not meet MASH crash test requirements.

T-101 – MDT Bridge Standard Drawing No. SBR-T101 – NCHRP 350 Test Level 3 passed. Code B.RH.01 as 3503.

W740 – MDT Bridge Standard Drawing No. SBR-W740 – NCHRP 350 Test Level 3 passed. Code B.RH.01 as 3503.

W830 – MDT Bridge Standard Drawing No. SBR-W830 – NCHRP 350 Test Level 4 passed. Code B.RH.01 as 3504.

Concrete Barrier Rail – MDT Bridge Standard Drawing No. SBR-BBR. Note: this is no longer a current standard drawing for MDT, but was included in the manual because it is a typical standard for many of our bridges. This exact configuration has never been crash tested. Code B.RH.01 as ‘**I**’.

All other bridge rail should be coded as ‘**I**’ unless it meets county standards. Most counties with standard bridge rail refer to MDT standards. Interim guidance will be available as MDT Headquarters has time to research county standards. This guidance will be incorporated into the manual during the next update.

Some bridges have a median barrier between lanes of traffic. This also counts as bridge rail. Standards are listed below:

2 loop median barrier - not crash tested, no longer meets MDT standards. B.RH.01 = ‘**I**’.

3 loop median barrier – MDT HQ is still trying to track down the test level of the 3-loop barrier rail. More guidance is to follow.

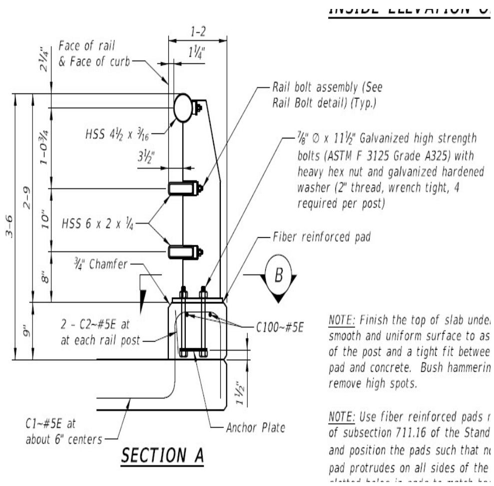
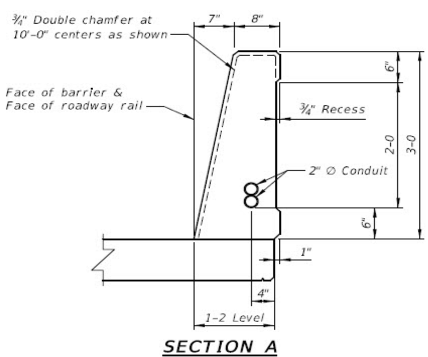


Figure 3.6-1 Open Bridge Rail 42”: B.RH.01 = M215



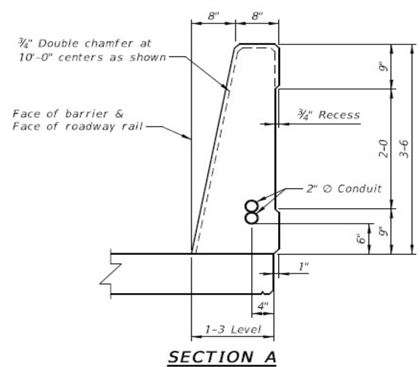


Figure 3.6-2 Single Slope Concrete Barrier Bridge Rail, could be 36” or 42”: B.RH.01 = S19

Figure 3.6-3 T-101 Rail on Concrete Deck: B.RH.01 = 3503

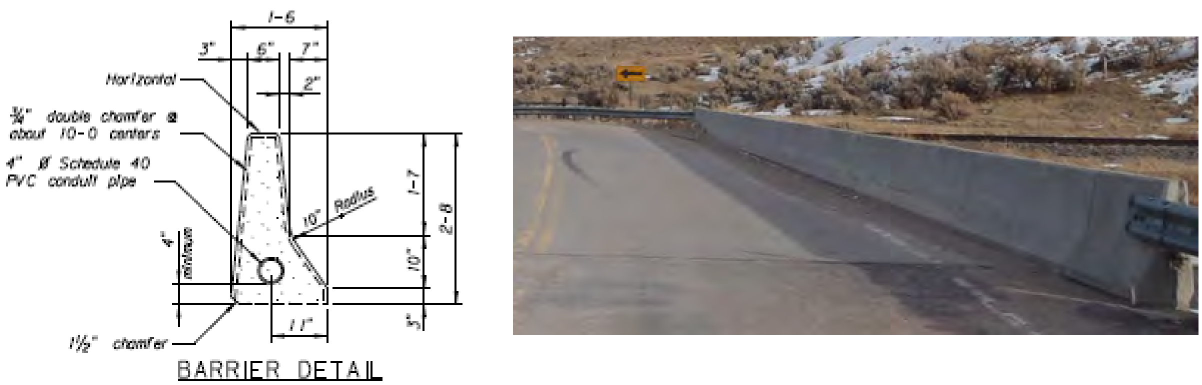


Figure 3.6-4 Concrete Barrier Rail: Code '**I**'

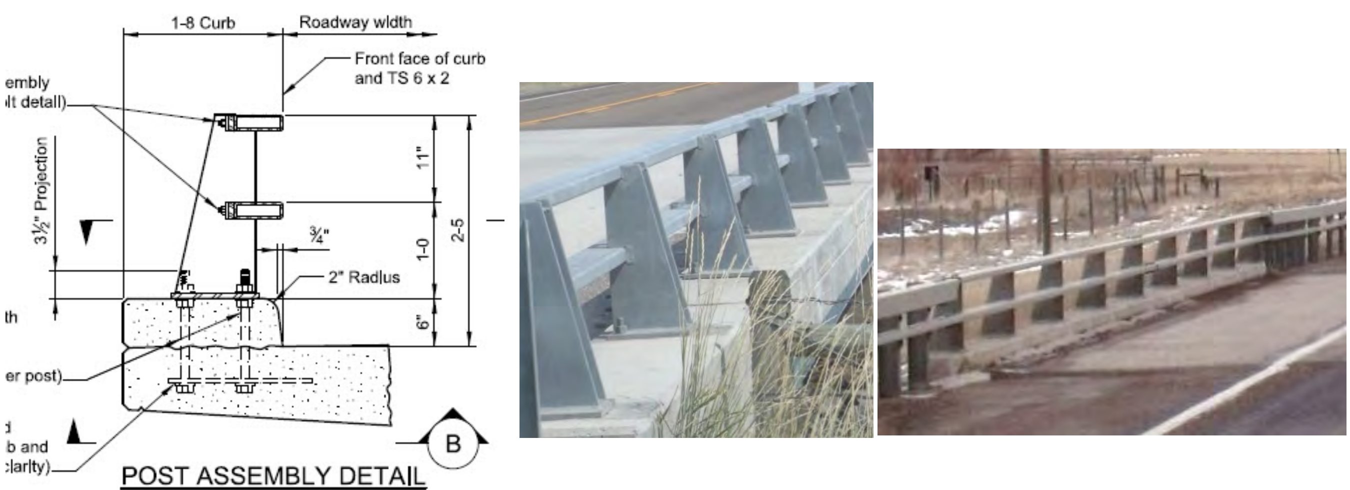


Figure 3.6-5 W740 bridge rail: B.RH.01 = 3503

Figure 3.6-6 W830 bridge rail: B.RH.01 = 3504

3.6.2 Transition Rail (B.RH.02)

More guidance will be released soon on coding SNBI item B.RH.02.

3.7 Measurement Forms

If plans with sufficient geometric information are not available to code inventory bridge geometrics, then a Measurement Form must be used to document these measurements. If neither exist for a particular bridge then the inspector needs to fill out a measurement form at the next scheduled inspection. When a Measurement Form exists the dimensions within it will be verified against any available plans and field measurements every ten years.

3.8 Note-Taking, Narrative Fields and Correspondence

Whenever a CS-3 or CS-4 condition exists for any element, at minimum a narrative comment and at least one photo is required. Narrative fields in BrM will be via bullets as much as is practical. To avoid redundancy, notes from the previous inspection will not be copied and then repeated within narrative fields.

Correspondence and related documents for Critical Findings, Hydraulics Inspection Procedures, Load Posting, Load Ratings, Plans, Shop Drawings, Measurement Forms and Work Candidates will be uploaded to the Multimedia portion of BrM. Documents will be printed to PDF before being uploaded to BrM. If spreadsheets are intended to be used again, they will be uploaded in XLSX format. If documents are for one-time use and not intended to be used again, they will be printed to PDF before being uploaded. Anything permanent that should not be changed must be uploaded in PDF format.

3.9 NBI Condition Coding Guidelines for Repaired or Rehabilitated Components

Repaired and rehabilitated components can and will increase NBI condition ratings; however, no repaired component is to be rated higher than 7. Components that are replaced are typically rated 8 or 9. Repairs intended to be temporary in nature, like bituminous patches in concrete decks will not be considered to improve condition. Repairs that do not fix the defect and only slow down deterioration (such as painting) will not be considered to improve the condition.

3.10 Pedestrian Bridges

Certain bridges which are designed for and used by pedestrians are also part of Montana's inspection inventory and include bridges that are state owned or over the state Right of Way. Also note that certain bridges that are privately owned and are over the state Right of Way are also inspected. These bridges will be inspected and documented in the same manner as a highway bridge. Naming convention for pedestrian bridges is different – there is a P in front of the ID number (ex: P1234). The NBI ID will match the MDTID, but they are not reported to FHWA. They will typically not have a load rating.

3.11 Object Markers

Object Marker defects will be noted in the Inspection Notes section of BrM, especially when there is a work item associated with it. See Section 9.3.3 for additional guidance for adding Repair Suggestions.

3.12 Load Posting Coding Guidance

There are several different posting scenarios that may exist at a bridge, each requiring different coding. Load posting changes (B.PS.01, B.PS.02, comments and supporting photos, B.EP.03 and B.EP.04 when applicable) must be updated in BrM immediately upon return from the field inspection. This guidance explains each scenario and what steps Inspectors and Headquarters should take when coding load posting items.

3.12.1 Load Posting Status Changes

A new Load Posting Status Event will be added to BrM every time the load posting status is changed and will contain the following: posting status change date, posting status, comments, and posting values (if applicable). Comments will clearly state the reason for coding, along with the full name and company of the person making the change. Supporting photos will be uploaded to Multimedia.

Comment Format:

<Description/reason for B.PS.01 coding> <Name of person who changed B.PS.01> <Company>.

Comment Example:

Eastbound posting sign found to be missing during routine inspection, 1/1/2021, John Doe, MDT.

3.12.2 Scenario-Based Posting Status Coding

Reserved

3.12.3 Posting Types and Values

Reserved

Chapter 3 Appendices

Appendix 3A
Roadway Clearance Templates

MONTANA Department of Transportation

General Inspection Information	
Inspection Group:	
Team Leader:	
Inspection Completion Date (B.IE.02):	

BRIDGE UNDER-CLEARANCE INVENTORY DATA SHEET

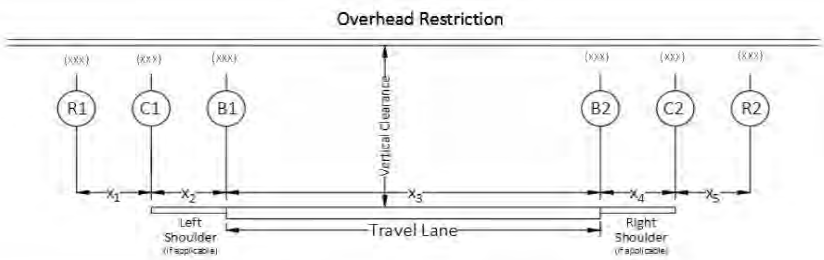
For One Lane Roadway

General Bridge Information	
Bridge Number (B.ID.01):	
Feature Carried:	
Feature Intersected:	
Span Number:	
Direction of Travel Lanes Under:	
Minimum Clearance:	
Posted Clearance Sign(s):	

SNBI Items		
Item ID	Data Item Name	Code
B.H.12	Highway Max Usable Vertical Clearance	
B.H.13	Highway Min Vertical Clearance	
B.H.14	Highway Min Horizontal Clearance, Left	
B.H.15	Highway Min Horizontal Clearance, Right	
B.H.16	Highway Max Usable Surface Width	

<u>Guidance:</u>

1. Orient cross-section based on direction of traffic.
2. Adjust the "(xxx)" text in each text box to label cross-section features accordingly (i.e., C1 = north curb, L2 = dashed white line/DWL, D2 = south abutment toe of slope, etc.).
3. Select the appropriate fascia in the **Horizontal Clearances Table** from the drop down lists.
4. Overwrite the names of overhead restrictions to be consistent with report nomenclature.
5. Measure and record horizontal under-clearances from cross-section feature to feature at each fascia, perpendicular to the roadway.
6. Measure and record vertical under-clearances to lowest bridge member restriction, appurtenance attached to bridge, or other structure at the following roadway cross-section points:
   a. Along each curb line.
   b. Along each shoulder line.
   c. Along each travel lane line.
7. Measure and record highway maximum usable vertical clearance (Item B.H.12) as necessary; interpolation acceptable for non-curved lowest bridge member restrictions (i.e., beams).
8. Determine and document specific cross-section features as flush with the travel lanes or mountable.
9. Use centerline of roadway stripes and vertical face closest to the roadway for all other cross-section features as measuring points.
10. Assume 12' wide travel lanes if roadway lines are not visible, and evenly divide remaining roadway width for assumed shoulder widths.
11. Enter zeros for the following situations:
    a. Horizontal Clearances:
       i. For X_1 if C1 is a non-mountable barrier.
       ii. For X_2 and/or X_4 if a shoulder does not exist AND shoulder width cannot be assumed.
       iii. For X_5 if C2 is a non-mountable barrier.
    b. Vertical Clearances:
       i. If curb or shoulder line does not exist AND travel lane widths cannot be assumed.
12. Use a separate sheet for each direction of travel at bridges intersecting a divided highway.



Are the following features flush with the travel lanes or mountable (<6")?				
	C1	B1	B2	C2
Yes	☐	☐	☐	☐
No/NA	☐	☐	☐	☐

Horizontal Clearances Table										
Fascia	X_1		X_2		X_3		X_4		X_5	
	(ft)	(in)	(ft)	(in)	(ft)	(in)	(ft)	(in)	(ft)	(in)

Vertical Clearances Table								
Overhead Restriction	Lane Delineator							
	C1		B1		B2		C2	
	(ft)	(in)	(ft)	(in)	(ft)	(in)	(ft)	(in)
Beam 1								
Beam 2								
Beam 3								
Beam 4								
Beam 5								
Beam 6								
Beam 7								
Beam 8								
Beam 9								
Beam 10								
Beam 11								

Notes:

MONTANA Department of Transportation

General Inspection Information	
Inspection Group:	
Team Leader:	
Inspection Completion Date (B.IE.02):	

BRIDGE UNDER-CLEARANCE INVENTORY DATA SHEET

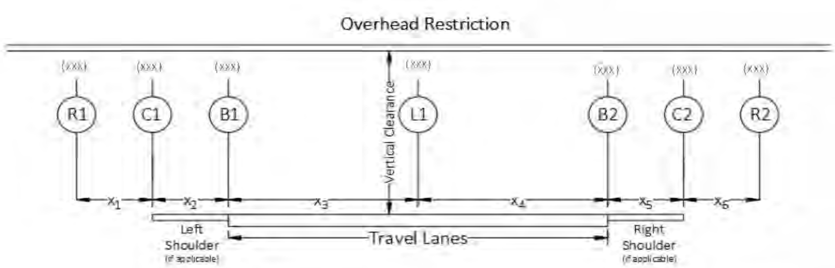
For Two Lane Roadway

General Bridge Information	
Bridge Number (B.ID.01):	
Feature Carried:	
Feature Intersected:	
Span Number:	
Direction of Travel Lanes Under:	
Minimum Clearance:	
Posted Clearance Sign(s):	

SNBI Items		
Item ID	Data Item Name	Code
B.H.12	Highway Max Usable Vertical Clearance	
B.H.13	Highway Min Vertical Clearance	
B.H.14	Highway Min Horizontal Clearance, Left	
B.H.15	Highway Min Horizontal Clearance, Right	
B.H.16	Highway Max Usable Surface Width	

Guidance:

1. Orient cross-section based on direction of traffic.
2. Adjust the "(xxx)" text in each text box to label cross-section features accordingly (i.e., C1 = north curb, L2 = dashed white line/DWL, D2 = south abutment toe of slope, etc.).
3. Select the appropriate fascia in the **Horizontal Clearances Table** from the drop down lists.
4. Overwrite the names of overhead restrictions to be consistent with report nomenclature.
5. Measure and record horizontal under-clearances from cross-section feature to feature at each fascia, perpendicular to the roadway.
6. Measure and record vertical under-clearances to lowest bridge member restriction, appurtenance attached to bridge, or other structure at the following roadway cross-section points:
   a. Along each curb line.
   b. Along each shoulder line.
   c. Along each travel lane line.
7. Measure and record highway maximum usable vertical clearance (Item B.H.12) as necessary; interpolation acceptable for non-curved lowest bridge member restrictions (i.e., beams).
8. Determine and document specific cross-section features as flush with the travel lanes or mountable.
9. Use centerline of roadway stripes and vertical face closest to the roadway for all other cross-section features as measuring points.
10. Assume 12' wide travel lanes if roadway lines are not visible, and evenly divide remaining roadway width for assumed shoulder widths.
11. Enter zeros for the following situations:
    a. Horizontal Clearances:
       i. For X_1 if C1 is a non-mountable barrier.
       ii. For X_2 and/or X_5 if a shoulder does not exist AND shoulder width cannot be assumed.
       iii. For X_6 if C2 is a non-mountable barrier.
    b. Vertical Clearances:
       i. If curb or shoulder line does not exist AND travel lane widths cannot be assumed.
12. Use a separate sheet for each direction of travel at bridges intersecting a divided highway.



Are the following features flush with the travel lanes or mountable (<6")?				
	C1	B1	B2	C2
Yes	☐	☐	☐	☐
No/NA	☐	☐	☐	☐

Is the under feature a two-direction undivided roadway?	
Yes	☐
No	☐

Horizontal Clearances Table												
Fascia	X_1		X_2		X_3		X_4		X_5		X_6	
	(ft)	(in)	(ft)	(in)	(ft)	(in)	(ft)	(in)	(ft)	(in)	(ft)	(in)

Vertical Clearances Table										
Overhead Restriction	Lane Delineator									
	C1		B1		L1		B2		C2	
	(ft)	(in)	(ft)	(in)	(ft)	(in)	(ft)	(in)	(ft)	(in)
Beam 1										
Beam 2										
Beam 3										
Beam 4										
Beam 5										
Beam 6										
Beam 7										
Beam 8										
Beam 9										
Beam 10										
Beam 11										

Notes:

MONTANA Department of Transportation

General Inspection Information	
Inspection Group:	
Team Leader:	
Inspection Completion Date (B.IE.02):	

BRIDGE UNDER-CLEARANCE INVENTORY DATA SHEET

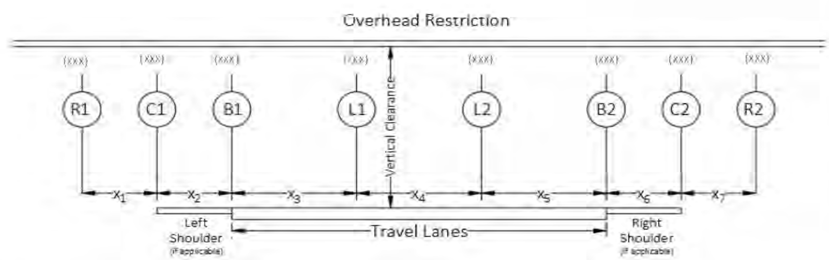
For Three Lane Roadway

General Bridge Information	
Bridge Number (B.ID.01):	
Feature Carried:	
Feature Intersected:	
Span Number:	
Direction of Travel Lanes Under:	
Minimum Clearance:	
Posted Clearance Sign(s):	

SNBI Items		
Item ID	Data Item Name	Code
B.H.12	Highway Max Usable Vertical Clearance	
B.H.13	Highway Min Vertical Clearance	
B.H.14	Highway Min Horizontal Clearance, Left	
B.H.15	Highway Min Horizontal Clearance, Right	
B.H.16	Highway Max Usable Surface Width	

<u>Guidance:</u>

1. Orient cross-section based on direction of traffic.
2. Adjust the "(xxx)" text in each text box to label cross-section features accordingly (i.e., C1 = north curb, L2 = dashed white line/DWL, D2 = south abutment toe of slope, etc.).
3. Select the appropriate fascia in the **Horizontal Clearances Table** from the drop down lists.
4. Overwrite the names of overhead restrictions to be consistent with report nomenclature.
5. Measure and record horizontal under-clearances from cross-section feature to feature at each fascia, perpendicular to the roadway.
6. Measure and record vertical under-clearances to lowest bridge member restriction, appurtenance attached to bridge, or other structure at the following roadway cross-section points:
   a. Along each curb line.
   b. Along each shoulder line.
   c. Along each travel lane line.
7. Measure and record highway maximum usable vertical clearance (Item B.H.12) as necessary; interpolation acceptable for non-curved lowest bridge member restrictions (i.e., beams).
8. Determine and document specific cross-section features as flush with the travel lanes or mountable.
9. Use centerline of roadway stripes and vertical face closest to the roadway for all other cross-section features as measuring points.
10. Assume 12' wide travel lanes if roadway lines are not visible, and evenly divide remaining roadway width for assumed shoulder widths.
11. Enter zeros for the following situations:
    a. Horizontal Clearances:
       i. For X_1 if C1 is a non-mountable barrier.
       ii. For X_2 and/or X_6 if a shoulder does not exist AND shoulder width cannot be assumed.
       iii. For X_7 if C2 is a non-mountable barrier.
    b. Vertical Clearances:
       i. If curb or shoulder line does not exist AND travel lane widths cannot be assumed.
12. Use a separate sheet for each direction of travel at bridges intersecting a divided highway.



Are the following features flush with the travel lanes or mountable (<6")?				
	C1	B1	B2	C2
Yes	☐	☐	☐	☐
No/NA	☐	☐	☐	☐

Is the under feature a two-direction undivided roadway?	
Yes	☐
No	☐

Horizontal Clearances Table

Fascia	X_1		X_2		X_3		X_4		X_5		X_6		X_7	
	(ft)	(in)	(ft)	(in)	(ft)	(in)	(ft)	(in)	(ft)	(in)	(ft)	(in)	(ft)	(in)

Vertical Clearances Table

Overhead Restriction	Lane Delineator											
	C1		B1		L1		L2		B2		C2	
	(ft)	(in)	(ft)	(in)	(ft)	(in)	(ft)	(in)	(ft)	(in)	(ft)	(in)
Beam 1												
Beam 2												
Beam 3												
Beam 4												
Beam 5												
Beam 6												
Beam 7												
Beam 8												
Beam 9												
Beam 10												
Beam 11												

Notes:

General Inspection Information	
Inspection Group:	
Team Leader:	
Inspection Completion Date (B.IE.02):	

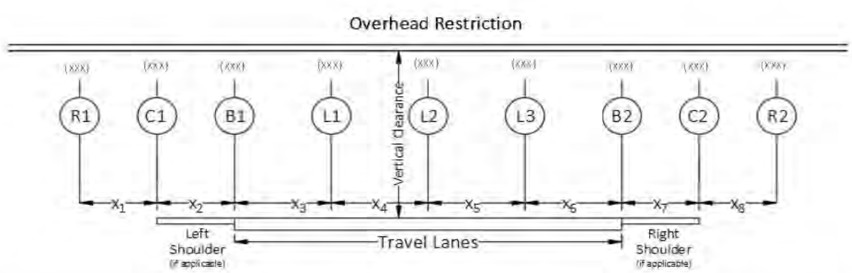
MONTANA Department of Transportation

BRIDGE UNDER-CLEARANCE INVENTORY DATA SHEET
For Four Lane Roadway

General Bridge Information	
Bridge Number (B.ID.01):	
Feature Carried:	
Feature Intersected:	
Span Number:	
Direction of Travel Lanes Under:	
Minimum Clearance:	
Posted Clearance Sign(s):	

SNBI Items		
Item ID	Data Item Name	Code
B.H.12	Highway Max Usable Vertical Clearance	
B.H.13	Highway Min Vertical Clearance	
B.H.14	Highway Min Horizontal Clearance, Left	
B.H.15	Highway Min Horizontal Clearance, Right	
B.H.16	Highway Max Usable Surface Width	

Guidance:
1. Orient cross-section based on direction of traffic.
2. Adjust the "(xxx)" text in each text box to label cross-section features accordingly (i.e., C1 = north curb, L2 = dashed white line/DWL, D2 = south abutment toe of slope, etc.).
3. Select the appropriate fascia in the **Horizontal Clearances Table** from the drop down lists.
4. Overwrite the names of overhead restrictions to be consistent with report nomenclature.
5. Measure and record horizontal under-clearances from cross-section feature to feature at each fascia, perpendicular to the roadway.
6. Measure and record vertical under-clearances to lowest bridge member restriction, appurtenance attached to bridge, or other structure at the following roadway cross-section points:
   a. Along each curb line.
   b. Along each shoulder line.
   c. Along each travel lane line.
7. Measure and record highway maximum usable vertical clearance (Item B.H.12) as necessary; interpolation acceptable for non-curved lowest bridge member restrictions (i.e., beams).
8. Determine and document specific cross-section features as flush with the travel lanes or mountable.
9. Use centerline of roadway stripes and vertical face closest to the roadway for all other cross-section features as measuring points.
10. Assume 12' wide travel lanes if roadway lines are not visible, and evenly divide remaining roadway width for assumed shoulder widths.
11. Enter zeros for the following situations:
    a. Horizontal Clearances:
       i. For X_1 if C1 is a non-mountable barrier.
       ii. For X_2 and/or X_7 if a shoulder does not exist AND shoulder width cannot be assumed.
       iii. For X_8 if C2 is a non-mountable barrier.
    b. Vertical Clearances:
       i. If curb or shoulder line does not exist AND travel lane widths cannot be assumed.
12. Use a separate sheet for each direction of travel at bridges intersecting a divided highway.



Are the following features flush with the travel lanes or mountable (<6")?				
	C1	B1	B2	C2
Yes	☐	☐	☐	☐
No/NA	☐	☐	☐	☐

Is the under feature a two-direction undivided roadway?	
Yes	☐
No	☐

Horizontal Clearances Table																
Fascia	X_1		X_2		X_3		X_4		X_5		X_6		X_7		X_8	
	(ft)	(in)	(ft)	(in)	(ft)	(in)	(ft)	(in)	(ft)	(in)	(ft)	(in)	(ft)	(in)	(ft)	(in)

Vertical Clearances Table														
Overhead Restriction	Lane Delineator													
	C1		B1		L1		L2		L3		B2		C2	
	(ft)	(in)	(ft)	(in)	(ft)	(in)	(ft)	(in)	(ft)	(in)	(ft)	(in)	(ft)	(in)
Beam 1														
Beam 2														
Beam 3														
Beam 4														
Beam 5														
Beam 6														
Beam 7														
Beam 8														
Beam 9														
Beam 10														
Beam 11														

Notes:

Appendix 3B
Railroad Clearance Templates

General Inspection Information	
Inspection Group:	
Team Leader:	
Inspection Completion Date (B.IE.02):	

BRIDGE UNDER-CLEARANCE INVENTORY DATA SHEET

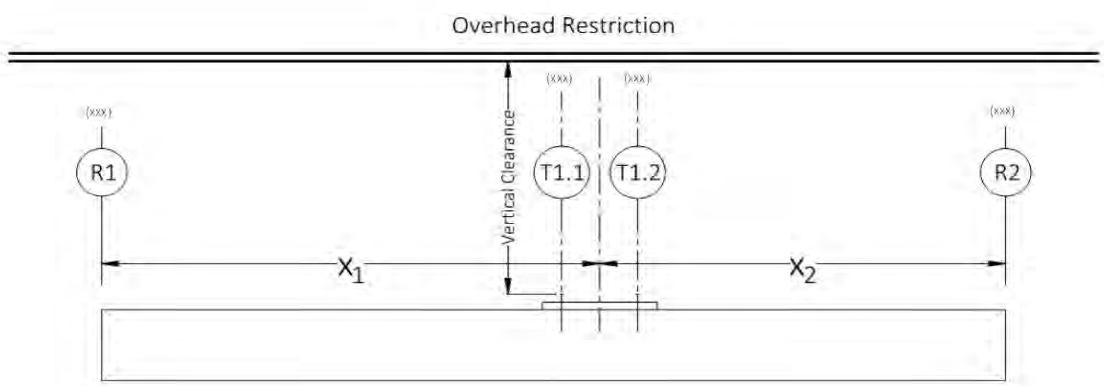
For One Track Railroad

General Bridge Information	
Bridge Number (B.ID.01):	
Feature Carried:	
Feature Intersected:	
Span Number:	
Minimum Clearance:	
Posted Clearance Sign(s):	

Guidance:

1. Adjust the "(xxx)" text in each text box to label cross-section features accordingly (i.e., C1 = north abutment, T1 = track, etc.).
2. Select the appropriate fascia in the **Horizontal Clearances Table** from the drop down lists.
3. Overwrite the names of overhead restrictions to be consistent with report nomenclature.
4. Measure and record horizontal clearances perpendicular from centerline of the tracks to the nearest substructure unit or toe of slope that is steeper than 1V:3H.
5. Measure and record vertical clearance from the top of rails to the lowest bridge restriction.
   a. Restrictions that serve only a railroad purpose (i.e. catenary systems) are excluded from the measurement and do not reduce the vertical clearance.
6. Vertical and horizontal clearances greater than 30' can be estimated.
7. Report 99.9 when the vertical or horizontal clearance is 100' or greater.

SNBI Items		
Item ID	Data Item Name	Code
B.RR.02	Railroad Minimum Vertical Clearance	
B.RR.03	Railroad Minimum Horizontal Offset	



Horizontal Clearances Table				
Fascia	X_1		X_2	
	(ft)	(in)	(ft)	(in)

Vertical Clearances Table				
Overhead Restriction	Rail Location			
	T1.1		T1.2	
	(ft)	(in)	(ft)	(in)
Beam 1				
Beam 2				
Beam 3				
Beam 4				
Beam 5				
Beam 6				
Beam 7				
Beam 8				
Beam 9				
Beam 10				
Beam 11				

Notes:

MONTANA Department of Transportation

General Inspection Information	
Inspection Group:	
Team Leader:	
Inspection Completion Date (B.IE.02):	

BRIDGE UNDER-CLEARANCE INVENTORY DATA SHEET

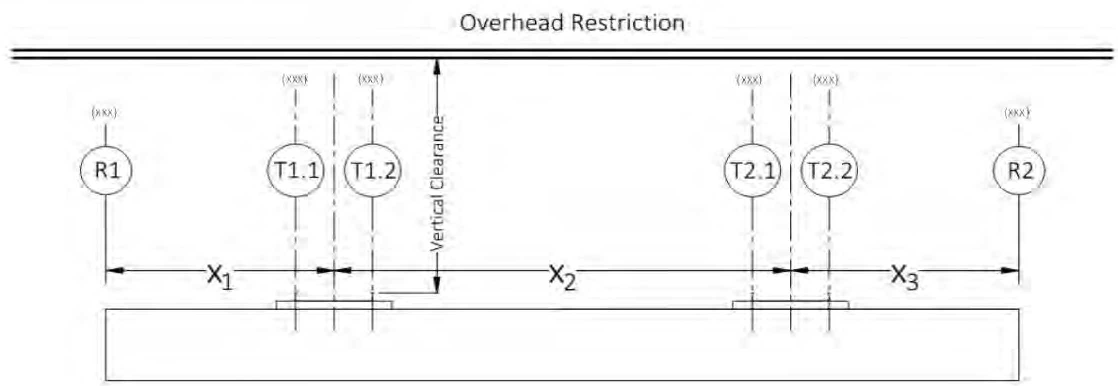
For Two Track Railroad

General Bridge Information	
Bridge Number (B.ID.01):	
Feature Carried:	
Feature Intersected:	
Span Number:	
Minimum Clearance:	
Posted Clearance Sign(s):	

Guidance:

1. Adjust the "(xxx)" text in each text box to label cross-section features accordingly (i.e., C1 = north abutment, T1 = track, etc.).
2. Select the appropriate fascia in the **Horizontal Clearances Table** from the drop down lists.
3. Overwrite the names of overhead restrictions to be consistent with report nomenclature.
4. Measure and record horizontal clearances perpendicular from centerline of the tracks to the nearest substructure unit or toe of slope that is steeper than 1V:3H.
5. Measure and record vertical clearance from the top of rails to the lowest bridge restriction.
   a. Restrictions that serve only a railroad purpose (i.e. catenary systems) are excluded from the measurement and do not reduce the vertical clearance.
6. Vertical and horizontal clearances greater than 30' can be estimated.
7. Report 99.9 when the vertical or horizontal clearance is 100' or greater.

SNBI Items		
Item ID	Data Item Name	Code
B.RR.02	Railroad Minimum Vertical Clearance	
B.RR.03	Railroad Minimum Horizontal Offset	



Horizontal Clearances Table						
Fascia	X_1		X_2		X_3	
	(ft)	(in)	(ft)	(in)	(ft)	(in)

Vertical Clearances Table								
Overhead Restriction	Rail Location				Rail Location			
	T1.1		T1.2		T2.1		T2.2	
	(ft)	(in)	(ft)	(in)	(ft)	(in)	(ft)	(in)
Beam 1								
Beam 2								
Beam 3								
Beam 4								
Beam 5								
Beam 6								
Beam 7								
Beam 8								
Beam 9								
Beam 10								
Beam 11								

Notes:

General Inspection Information	
Inspection Group:	
Team Leader:	
Inspection Completion Date (B.IE.02):	

MONTANA Department of Transportation

BRIDGE UNDER-CLEARANCE INVENTORY DATA SHEET

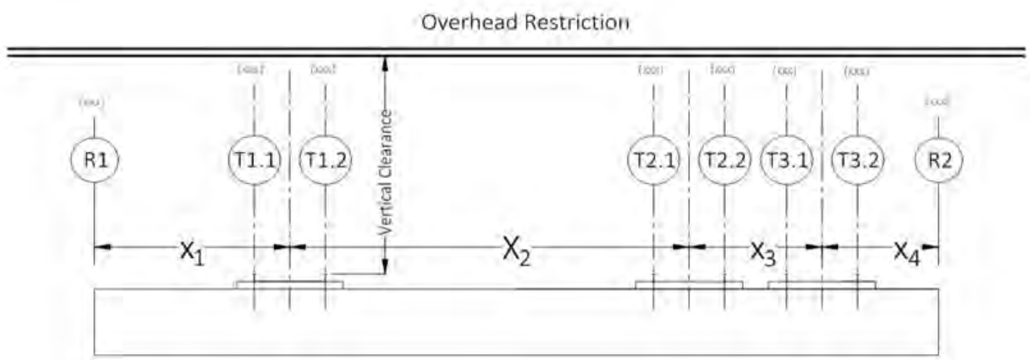
For Three Track Railroad

General Bridge Information	
Bridge Number (B.ID.01):	
Feature Carried:	
Feature Intersected:	
Span Number:	
Minimum Clearance:	
Posted Clearance Sign(s):	

Guidance:

1. Adjust the "(xxx)" text in each text box to label cross section features accordingly (i.e., C1 = north abutment, T1 = track, etc.).
2. Select the appropriate fascia in the **Horizontal Clearances Table** from the drop down lists.
3. Overwrite the names of overhead restrictions to be consistent with report nomenclature.
4. Measure and record horizontal clearances perpendicular from centerline of the tracks to the nearest substructure unit or toe of slope that is steeper than 1V:3H.
5. Measure and record vertical clearance from the top of rails to the lowest bridge restriction.
   a. Restrictions that serve only a railroad purpose (i.e. catenary systems) are excluded from the measurement and do not reduce the vertical clearance.
6. Vertical and horizontal clearances greater than 30' can be estimated.
7. Report 99.9 when the vertical or horizontal clearance is 100' or greater.

SNBI Items		
Item ID	Data Item Name	Code
B.RR.02	Railroad Minimum Vertical Clearance	
B.RR.03	Railroad Minimum Horizontal Offset	



Horizontal Clearances Table								
Fascia	X_1		X_2		X_3		X_4	
	(ft)	(in)	(ft)	(in)	(ft)	(in)	(ft)	(in)

Vertical Clearances Table												
Overhead Restriction	Rail Location				Rail Location				Rail Location			
	T1.1		T1.2		T2.1		T2.2		T3.1		T3.2	
	(ft)	(in)	(ft)	(in)	(ft)	(in)	(ft)	(in)	(ft)	(in)	(ft)	(in)
Beam 1												
Beam 2												
Beam 3												
Beam 4												
Beam 5												
Beam 6												
Beam 7												
Beam 8												
Beam 9												
Beam 10												
Beam 11												

Notes:

Appendix 3C
MDT Bridge Naming History

In the past, MDT bridges only had one ID. An NBI ID was assigned to each bridge regardless of whether it met requirements of the NBI or not. Each of those IDs had a meaning based on the bridge's location. The ID started with a letter indicating the type of route carried and numbers representing route and milepost. See the examples below:

1) I00015249+05052 can be broken up as I 00015 249+0505 2.
   a) I – interstate bridge
   b) 00015 – route 15 (in other words, I-15)
   c) 249+0505 – milepost 249 plus 0.505 miles to the location of the bridge. (In the field, some mileposts are more than 1 mile apart, which is why we sometimes have IDs like I00015249+15052)
2) This is the second bridge in a pair of bridges in the same location. Most of our bridge pairs are interstate bridges, but there are a few that are not on the interstate. The last number in the old NBI ID indicates which bridge it is. 1 means it is the only bridge in that location on the route or it is the bridge in a pair that carries traffic in the direction the bridge is inventoried. 2 indicates the bridge in a pair on the side of the roadway that carries traffic in the opposite direction of the inventory direction. For example, on I-15 and I-90, a 1 bridge is the northbound bridge, and a 2 bridge is the southbound bridge. On I-94, the 1 bridge is the eastbound bridge, and the 2 bridge is the westbound bridge. In some cases, there are NBI IDs ending in 3 and 4. These indicate interstate ramp bridges over the same feature crossed by the 1 and 2 bridges.
3) P00043029+00001 can be broken into P 00043 029+0000 1
   a) P – Primary Route
   b) 00043 – route 43. Combined with the P, this makes the route ID P-43.
   c) 029+0000 – milepost 29.0
4) This is the only structure at this location on this route, or it is the structure that carries traffic in the direction the roadway is inventoried.
   a) L14103002+08001 can be broken into L 14 103 002+0800 1
   b) L – local route (typically county-owned)
   c) 14 – county number. In this case, Fergus County
   d) 103 – Fergus County route 103
   e) 002+0800 – milepost 2.8
5) This is the only structure at this location on this route, or it is the structure that carries traffic in the direction the roadway is inventoried.
6) NBI IDs that start with an S indicate secondary routes, and IDs that start with a W indicate pedestrian bridges.

Why did we add a second ID?

There were a few problems with the old NBI IDs:

1. When the IDs were originally assigned, FHWA still allowed changing of NBI IDs. Local route IDs are frequently changed by MDT's planning section, so MDT updated its NBI IDs to match. This caused a problem with keeping track of older files for the same bridge, so Bridge had to add a number to the end of the Feature Intersected field for bridges on Local routes to help us identify

which NBI IDs are for the same bridge. The featured intersected was unique for that bridge in that county. This is why the feature intersected for L14103002+08001 is Blood Creek 040. This information is still relevant if you are looking for the original inventory files of old bridges on local routes.

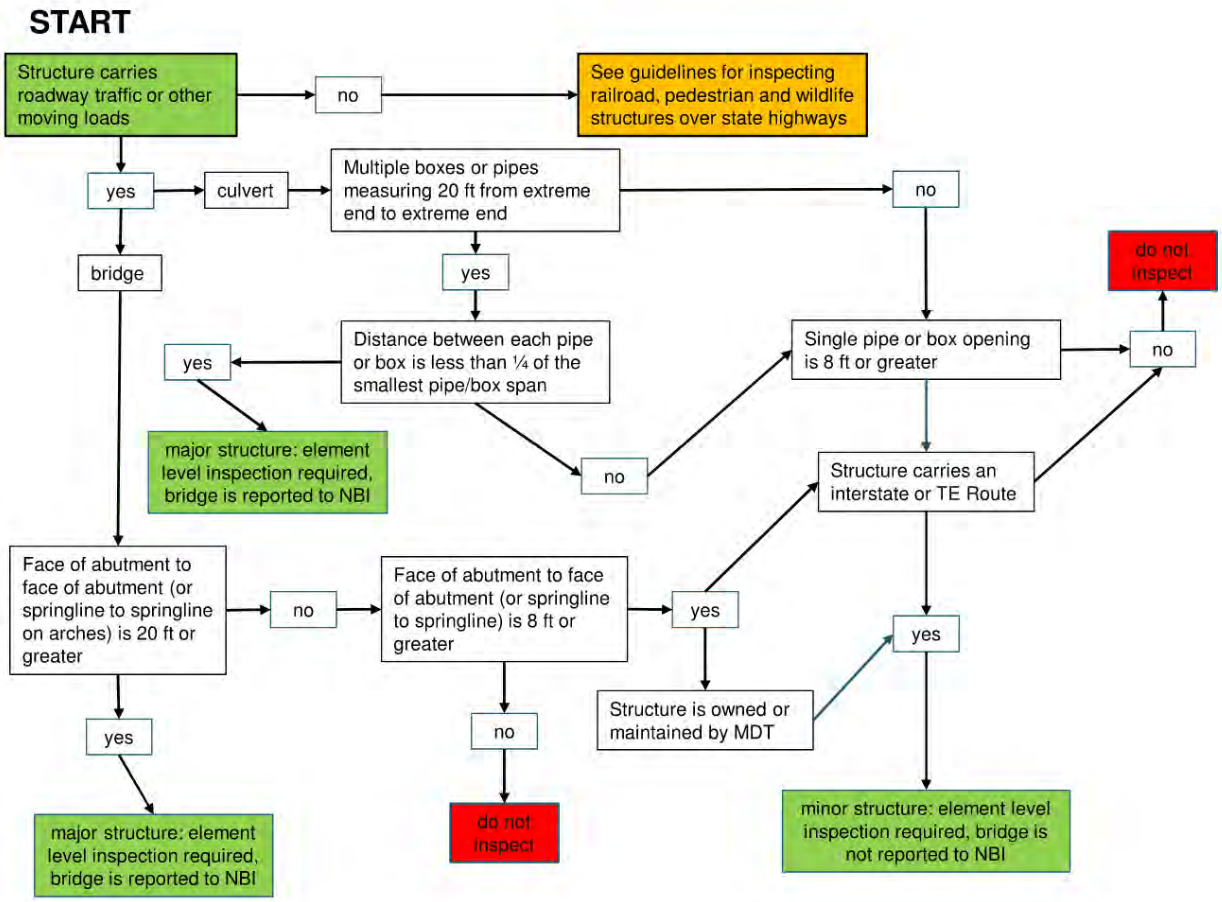
2. FHWA stopped allowing changes to NBI IDs. This stopped the issue in bullet 1, but created problems with bridge IDs not matching the correct route. It became concerning when a couple primary routes were reconstructed on a new alignment, but the old bridges were left in place on what is now considered a local route. At the time the new 5-digit bridge IDs were introduced, there were 3 bridges on local routes with primary route IDs.
3. FHWA only allows 15 digits for an NBI ID. Because MDT made full use of all 15 digits in our IDs, it became a problem when Planning started assigning 4-digit local route IDs. There is only room for a 3-digit ID in the NBI naming convention for local routes.
4. The NBI IDs do not differentiate between National Highway System (NHS) primaries and state primaries. This is likely because the routes numbers did not differentiate when the IDs were originally assigned. Now the route IDs start with an N for NHS routes, so a bridge ID starting with P00001 is for route N-1.
5. The NBI IDs were very long and difficult to remember. Why memorize a 15-digit ID when we only have around 5,000 bridges?
6. We were implementing new bridge inspection management software, so we had the ideal opportunity to make a change.

Five-digit IDs were created and assigned to the old NBI IDs in alphanumeric order, starting with bridge 01001. We originally called this the MDT ID, and it was intended to be a new ID that could be used to refer to each bridge without there being a meaning behind the ID that may or may not be correct. The plan was to change NBI IDs to match these 5-digit IDs as bridges are replaced.

After using the new IDs for about a year, the Bridge Management Section came up with the idea of a site-specific ID that gives us the ability to track all bridges that were originally in that location. The MDT ID was changed to the MDTSID. We soon realized that we had to do something different with the NBI IDs or we would not be able to have the MDTSID in every NBI ID. To fix this issue, we started putting the year the NBI ID was assigned into the NBI IDs along with the MDTSID. Instead of 01234 as an NBI ID, we would use 202401234. As of 2026 this is known as the MDTID.

A few structures were reported to FHWA with an NBI ID that exactly matches the MDTID. These look like anomalies in the numbering system but will not be a problem because the new NBI ID that follows the existing bridge will have the year added to it.

Appendix 3D
Structure Type Flowchart


START
Structure carries roadway traffic or other moving loads
no
See guidelines for inspecting railroad, pedestrian and wildlife structures over state highways
yes
culvert
Multiple boxes or pipes measuring 20 ft from extreme end to extreme end
no
bridge
yes
do not inspect
yes
Distance between each pipe or box is less than ¼ of the smallest pipe/box span
Single pipe or box opening is 8 ft or greater
no
major structure: element level inspection required, bridge is reported to NBI
no
Structure carries an interstate or TE Route
Face of abutment to face of abutment (or springline to springline on arches) is 20 ft or greater
no
Face of abutment to face of abutment (or springline to springline) is 8 ft or greater
yes
yes
Structure is owned or maintained by MDT
yes
no
major structure: element level inspection required, bridge is reported to NBI
do not inspect
minor structure: element level inspection required, bridge is not reported to NBI

Chapter 4– Inspection Types and Intervals

4.1 Inspection Types and Intervals

Each bridge must be inspected in accordance with the nationally recognized procedures in the latest version of the AASHTO Manual for Bridge Element Inspection (MBEI) and the Specifications for the National Bridge Inventory (SNBI).

All inspections are required to have the following:

- Condition codes within generally accepted tolerances.
- All notable bridge deficiencies identified.
- Condition codes supported by narrative that appropriately justifies and documents the rating or condition state assignment.

Generally acceptable tolerances for condition assessments occur when the inspector determined SNBI condition codes are within one value and within the same Good-Fair-Poor category of the review team's coding.

A nationally certified Bridge Inspection Team Leader must be at the bridge at all times during the following inspection types:

- Initial/Inventory
- Routine
- Underwater
- NSTM
- Impact/Damage
- Special

All bridges will receive thorough inspections, and all elements will be inspected when they are fully visible. If the inspector is unable to fully inspect any element during an inspection because it is obscured by snow, water, ice or any other environmental issue likely to improve at a different time of year, the bridge requires a follow-up inspection to collect the missing information needed to rate SNBI Condition Codes and Element Condition States.

Refer to Section 4.1.9 for examples of common situations where follow-up inspections may be required.

When reasonably possible, the inspector will shovel snow away from the bridge to make it visible for inspection. This will help avoid a follow-up inspection.

For efficiency, move as many inspection dates as possible to avoid follow-up inspections.

Inspect each bridge thoroughly to establish its condition and ensure the continued safe operation of the structure. Inspection types are listed below:

- Initial/Inventory
- Routine
- Underwater
- NSTM
- Impact/Damage
- Natural Disaster
- Load Rating Field Visit

- Overload
- Post Rehab
- Repair
- Scour Monitoring
- Service
- Temporary Bridge
- Update
- Other

The inspection types used for each bridge depend on several factors, including the type of bridge design, condition of the structure, and condition of the stream channel below the bridge.

To establish a regular inspection schedule, each district will review inventory records and knowledge of past conditions. The following factors may influence the inspection schedule:

- special inspection equipment needed
- low or high-water levels
- snow and ice conditions
- proximity of bridges to one another

By considering all these factors, a manageable schedule of inspection can be established and carried out.

4.1.1 Inspection Intervals

MDT Policy is to use the standard inspection intervals based on CFR 650.311 standard Method 1. These intervals are listed below:

- Routine Inspection Interval – 24 months
- Underwater Inspection Interval – 60 months
- NSTM Inspection Interval – 24 months

Special Inspections limited to localized deficiencies will be used in lieu of reduced interval Routine, NSTM, and Underwater Inspections. In such cases, a complete Routine, Underwater or Fracture Critical inspection will be conducted at the regularly scheduled interval. Special Inspection intervals are determined by the Bridge Inspection Program Manager and Load Rating Engineers.

4.1.1.1 Late Inspections

Documentation for late inspections must be entered into Inspection Notes on the Condition Page in BrM. Documentation must include:

- Relevant dates (including the date access was attempted, if applicable).
- Reason why the inspection was not completed on time.

The inspection team leader is responsible for documenting late inspection reasons. Notify MDT Bridge Management Headquarters before late inspections occur.

4.1.2 Initial/Inventory Inspections

An Initial/Inventory Inspection is the first inspection of bridges that are not already in the Structure Management System (BrM) and the first inspection of new bridges.

When a bridge is replaced by a new structure, or a bridge is fully closed to traffic during rehabilitation work, the Inventory Inspection and BrM data entry (including QC review) will be complete within 90 days of the bridge opening to traffic.

For an existing bridge that is open to public traffic during rehabilitation work, regularly scheduled Routine SNBI/Element inspections will be performed. If an inspection cannot be conducted on or before its due date because of reasonable circumstances such as a hazardous project site or conditions unfavorable to complete an inspection, then those circumstances will be documented and sent to the Bridge Inspection Program Manager, and the inspection will be rescheduled at the earliest date possible.

An Initial/Inventory Inspection consists of up to 3 steps, depending on the bridge being inspected as noted in the following subsections:

4.1.2.1 Determination of the Structure Location

For bridges that are new to the inventory (not previously in BrM), the structure location is determined using a GPS device and the aerial photos in BrM.

4.1.2.2 Collection of Inventory Data

Enter the bridge IDs into BrM following the bridge ID guidance in Chapter 3.

When available, the inspector will use the bridge construction plans to determine measurements, design type, material, and other pertinent inventory information. The inspector is responsible for obtaining bridge construction plans and shop drawings from local agencies and uploading these plans to BrM. When plans are not available for the bridge, the inspector will determine the inventory information for the bridge during a site visit. This includes filling out Bridge Measurement Forms as needed. Copies of Bridge Measurement Forms can be found on the **Forms** page of the MDT website.

4.1.2.3 Condition Inspection

The inspector will visit the bridge site to complete the initial condition inspection for the bridge. All inspection information will be entered into BrM within the Initial Inspection time frame stated previously.

4.1.3 Routine Inspections

A routine inspection is a condition inspection performed at regular intervals to monitor the condition of structures. The majority of inspections completed by MDT bridge inspectors are routine inspections.

Routine Inspection intervals do not exceed 24-months. Extended Intervals are not currently utilized during the transition to SNBI. An Extended Interval Policy will be documented and utilized by MDT at a later date.

During a routine inspection, the MDT inspection team is responsible for the following:

- Checking and verifying inventory information
- On-site condition inspection
- Completing BrM data entry for the condition inspection
- Updating any inventory information in BrM that is incorrect

4.1.4 Underwater Bridge Component Inspections

An inspection focusing on channel and underwater bridge components will be performed on bridges with substructure elements located underwater and not visible for inspection during Routine Inspections.

For structures whose underwater components can be accessed and inspected safely via wading, Probe and Wade Inspections (previously referred to as Probe and Wade) will be performed at the same time as the regular structure inspections. These are not considered Underwater Inspections. They are an extra piece of a Routine Inspection. If seasonal channel conditions or water levels prohibit inspections, consider shifting the scheduled Routine and Probe and Wade inspection dates to when conditions allow.

For structures whose underwater bridge components cannot be accessed and inspected via wading, Underwater Inspections will be performed. Underwater inspections are completed by consultants retained through the Bridge Management Section.

Underwater inspections are required every 60 months.

4.1.5 Nonredundant Steel Tension Member (NSTM) Inspections

A Nonredundant Steel Tension Member (NSTM) inspection is a focused, arm’s length inspection of bridge members identified as NSTMs.

An NSTM is defined as a primary steel member fully or partially in tension, and without load path redundancy, system redundancy or internal redundancy, whose failure may cause a portion of or the entire bridge to collapse. NSTM inspections are required every 24 months. See Chapter 5 for more information on NSTM inspections.

4.1.6 Damage Inspections

A damage inspection is an unscheduled inspection to assess structural damage resulting from environmental factors or human actions, such as vehicular collisions. The scope of the inspection depends on the extent of the damage. Damage inspections are typically used in the decision-making process for implementing emergency load restrictions or closures. They are also be used in the decision-making process to lift emergency restrictions that were put in place by Maintenance personnel until a Damage Inspection could be completed and the structure assessed for strength and structural stability.

4.1.7 Natural Disaster Inspections

Natural Disaster Inspections are unscheduled inspections to assess structural damage resulting from environmental factors such as earthquakes or floods. These inspections are to be completed by bridge inspectors after the Maintenance monitoring phase is completed following a Natural Disaster. They are intended to assess the full condition of a bridge after a natural disaster.

The following information is from MDT’s earthquake inspection criteria. It discusses inspections completed by MDT Maintenance personnel as a first-on-site assessment. It only applies to MDT owned and maintained bridges.

Bridge Inspectors will be engaged in cases where damage is found by Maintenance personnel.

4.1.7.1 MDT Owned Bridge Inspection Criteria for Earthquakes

The following criteria is provided to help determine when MDT Maintenance personnel should be directed to inspect bridges and other structures and the scope of those inspections. This is only a guideline and the intensity (determined from the effects on people, structures and the environment) for a specific event's magnitude may be different than what is listed below. As a result of this somewhat variable relationship between magnitude and intensity, events on the upper and lower bounds of the magnitude ranges listed below may be moved up or down, respectively, in response category if it is felt that it is warranted for a specific event. Possible conditions that may affect this decision are listed below:

- USGS intensity maps for a specific event
- whether an event is centered in or near an urban area or is in a very rural area with no or few structures
- discovering damage that is more severe than expected or damage that is more widespread than expected.

Guidelines for expected damage and timing of inspections are listed below:

- Magnitude 1.0 to 3.5 (Intensity I and II)
    - No damage expected.
    - No inspections necessary.
- Magnitude 3.6 to 4.9 (Intensity III, IV, and V)
    - No damage expected.
    - No immediate inspections are necessary if the event occurs after-hours or on the weekend. Contact the Bridge Bureau during the next regular work day to discuss the possible need for inspections and their scope. Any inspections that may be needed will be limited to an area in the immediate vicinity of the event.
- Magnitude 5.0 to 5.5 (Intensity VI)
    - Generally, no or very slight structural damage would be expected. Any damage would most likely be on structures located relatively close to the event center and be caused by rockfall, fault rupture, sinkhole, or other secondary events caused by the earthquake. Damage resulting directly from the earthquake energy waves would likely be so slight that it would be difficult for Level 1 inspection teams to distinguish between old damage (non-earthquake) and new damage (earthquake caused).
    - Inspections should begin as soon as convenient, beginning with the structures closest to the event. Lines of communication should be established with Bridge Bureau personnel and the Area Bridge Inspection Manager as soon as convenient to help determine the necessary scope and geographical limits of the inspections.
    - The need for closures or restrictions on structures is very unlikely, but possible.
- Magnitude 5.6 to 5.9 (Intensity VII)

- Slight to moderate damage is possible to heavier structures (steel, concrete). Damage from the earthquake energy waves and localized secondary events (rockfall, fault rupture, sinkholes, etc.) is possible.
- Inspections should begin as soon as teams can be contacted, regardless of the day of the week or time of day, beginning with the structures closest to the event. Bridge Bureau personnel should be contacted immediately to discuss the inspection plan, scope, and geographical limits of inspections. The Area Bridge Inspection Managers should also be contacted for assistance.
- The need for closures or restrictions on structures, although still unlikely, becomes more of a concern, especially for structures located relatively close to the event center.

- Magnitude 6.0 and greater (Intensity VII and above)
  - Moderate or greater damage is possible to widespread areas.
  - MDT Disaster Plan will likely need to be implemented.
  - The need for closures and restrictions become more likely as the magnitude increases.

Inspection of county bridges will follow the guidance above except that Maintenance personnel will not be available to complete initial evaluations. MDT bridge inspectors are responsible for quick damage assessments of each bridge followed by an in-depth Natural Disaster Inspection on every bridge where damage is noted. Coordinate inspections with the Bridge Inspection Engineer to add additional inspectors as needed.

Natural disaster inspections are required on all bridges where damage has been noted by bridge inspectors or MDT Maintenance personnel, regardless of ownership.

4.1.8 Special Inspections

Standard inspection intervals are used for Routine, Underwater, and Nonredundant Steel Tension Member inspections. Special Inspections will be used when a bridge requires an inspection interval that is less than the standard inspection intervals. These Special Inspections are limited to localized deficiencies identified in specific inspection procedures. The Inspection interval will be reduced using a Special Inspection based on three categories:

Element Defect Rating

Special Inspections may be added following an engineering review initiated when the Defect Condition State rating includes any quantity in Condition State 4 for the following defects:

- 1080 Delamination/Spall/Patched Area
- 1090 Exposed Rebar
- 1130 Concrete Cracking
- 1900 Distortion
- 4000 Settlement
- 7000 Damage
- 1000 Corrosion
- 1010 Steel Cracking
- 1020 Connection

- 1140 Decay/Section Loss
- 1150 Check/Shake
- 1160 Timber Cracking
- 1170 Split/Delamination (Timber)
- 2210 Movement
- 2220 Alignment
- 2240 Loss of Bearing Area
- 6000 Scour

Engineering Review of these defects in Condition State 4 will determine when a Special inspection is required. Special Inspection criteria for these conditions will be documented in Inspection Procedures.

Component Rating

Special Inspections are added when the Component Condition Rating is coded a 3 or less for:

- Item B.C.01 - Deck Condition Rating
- Item B.C.02 - Superstructure Condition Rating
- Item B.C.03 - Substructure Condition Rating
- Item B.C.04 - Culvert Condition Rating
- Item B.C.11 - Scour Condition Rating

Special Inspection intervals will not exceed 24 months when the following are in serious or worse condition - coded 3 or less:

- Item B.C.09 - Channel Condition Rating
- Item B.C.10 - Channel Protection Condition Rating
- Item B.C.15 - Underwater Inspection Condition

Special Inspection Intervals will not exceed 12 months when item B.C.14 - NSTM Inspection Condition is coded 4 or less.

Other Unique Situations

Special Inspections may also be added for other unique situations such as monitoring questionable defects, posted bridges, and other potentially hazardous conditions. In these situations, the Bridge Inspection Program Manager will determine if a Special Inspection is required.

Special Inspection Intervals will be determined based on level of defect severity, observed rate of deterioration, and other factors considered in engineering judgment. The Bridge Inspection Program Manager will determine the Special Inspection interval. Special Inspections will typically be assigned a 24-, 12-, 6-, 3-, or 1-month interval.

Adding Special Inspections

Once it is determined that a Special inspection is required, it will be scheduled in BrM and an inspection procedure will be written.

Modification to Special Inspection Schedule

An Inspector may request a change in the frequency (increase or decrease) of a Special Inspection due to repairs, deterioration to a worse condition, or no change in condition for an extended amount of time. Requests may also be made to remove a Special inspection and return to a Routine inspection only. This request needs to be sent to the Bridge Inspection Program Manager via email. The Bridge Inspection Program Manager will have the final say on modifying or removing the Special Inspection interval or process.

Condition-Based Defects

Condition-based defects are defects that affect the safety, serviceability, or structural integrity of a bridge. Some examples of these defects may include, but are not limited to:

- decay in timber elements (caps & piles)
- cracks in structural steel elements or connections
- corrosion section loss
- buckling or distortion in steel elements
- culvert defects (cracking, corrosion)
- distortion
- scour
- settlement
- severe concrete spalling or reinforcement section loss
- external non-bridge related items posing risk that may impact our structures or the traveling public
- any other miscellaneous structural defects

If an inspector finds something they believe warrants a Special inspection, they need to contact the Bridge Inspection Program Manager to determine Special Inspection needs. The Bridge Inspection Program Manager will determine if the Special inspection is required and the inspection frequency.

4.1.9 Follow-up Inspections

Follow-up inspections are required when the parts of a bridge that require inspection are not visible for inspection when the inspectors are on-site.

Shown below in Figures 4.1-1 to 4.1-4 are common situations where a follow-up inspection would be required.

Figure 4.1-1 A follow-up inspection is required to check the condition of the bridge deck and associated elements (joints, rail, etc.).

Figure 4.1-2 A follow-up inspection is required to check the condition of the wingwalls, abutments, and part of the exterior girder.

Figure 4.1-3 A follow-up inspection is required to check the condition of the bottom of the abutments and to check for scour.

Figure 4.1-4 A follow-up inspection is required to check the condition of the pipe culverts.

4.1.10 Other Inspections

4.1.10.1 Pin and Hanger NDT Inspections

Pin and Hanger assemblies are inspected using non-destructive testing methods. MDT contracts with certified consultants to perform these inspections. Pin and Hanger inspections are required every 48 months.

4.1.10.2 Steel Bridge Inspection: Non-NSTM Hands-on Inspection Frequency

Steel members that are not considered NSTMs are required to receive a hands-on inspection for their first and second inspections after construction. After the first two inspections, hands-on access may be reduced according to the following table, or as determined by the Bridge Inspection Program Manager:

NBI Item B.C.02 Rating	Hands-on Inspection Frequency (months)
7 and above	96
6	72
5	48
4	24
3 and below	*

*Determined by Bridge Inspection Program Manager

Hands-on inspection frequency is determined by the Bridge Inspection Program Manager when the bridge meets any of the following criteria:

- Any fatigue cracks are present in the steel members
- There are fatigue cracks in the bridge's twin interstate structure. If the second structure is not identical to the cracked one, this does not apply.
- Steel members contain multiple fatigue prone details such as welded transverse stiffeners, welded cover plates, or welded longitudinal stiffeners.
- Impact damage or other defects in steel members that warrant frequent monitoring
- High Average Daily Truck Traffic (general rule: ADTT > 1,000)
- Bridge nominated by an Engineer, Inspector or Local Agency Owner and approved by Bridge Inspection Program Manager

District Bridge Inspection Managers are responsible to ensure hands-on inspections are performed within the appropriate frequency. Any observations or information that warrants a change in inspection frequency is required to be brought to the Bridge Inspection Program Manager's attention within one month of the field inspection.

Hands-on inspection frequency is scheduled through the UBIV Inspection type in BrM. The frequency of UBIV inspections is also recorded in BrM attribute MDT134 UBIV Frequency.

When the Superstructure Condition Rating (B.C.02) is reduced due to an inspection that is not hands-on, the Team Leader and District Bridge Inspection Manager will work together to determine if an immediate follow-up hands-on inspection is necessary. The follow-up inspection may or may not require a UBIV, depending on access to the structure. The Team leader will include an explanation of why the bridge will or will not receive an immediate follow-up hands-on inspection in the MDT Inspection Notes.

4.1.10.3 Complex Bridges

Complex bridges require additional procedures and inspector training for thorough inspection. These additional procedures and training are due to complex bridge features and complex risk factors. The features and risk factors of a bridge will be considered using the following guidance when determining if a bridge meets Complex Bridge Inspection criteria. Inspection Team Leaders and Inspection Managers will identify potentially complex bridges using this guidance. Determining if a bridge is complex will include Bridge Management Headquarters engineers.

Complex Features

Complex features may be identified due to a Bridge's Design, Construction, or Inspectability. Complex features may include:

- Suspension Cables
- Stay Cables
- Anchorages of Cables and Post Tensioning
- Electrical Systems
- Mechanical Systems
- Operational Systems and Controls
- Floating Bridge Components
- Materials with known problems
- Special Seismic Features

Risk Factors

Complex bridges will also be identified considering risk factors. These are factors that have inspection, condition, structural, or service risk. These risks may require specialized equipment due to difficult access or conditions, or detailed procedures related to past structural problems.

Complex Inspection Risk Factors may include:

- Complex Structural Response
- Difficult access
- Specialized inspection equipment needs
- High ADT or ADTT
- Low Redundancy
- History of Past problems

Bridges of uncommon design type may be considered Complex, aiding inspectors with guidance and procedures for unfamiliar bridge features and risks. Bridges with known construction, rehabilitation, or materials problems may also be considered for complex inspection. These known problems will be identified in the specific inspection procedures.

Complex Bridge Inspection Procedures

Complex Bridge inspection procedures will be developed for each bridge that is identified as Complex. Procedures will identify accessibility risks and describe special equipment or precautions required for access. Each complex feature will be listed in the procedure. These features will be identified by hands-on inspection and careful study of the plans. Historic structural, construction, or rehabilitation issues will be listed. Each complex feature listed will have guidance on how to perform a thorough inspection. Each complex risk will also have guidance for performing a thorough inspection. This guidance will identify what to look for, and how to document condition and defects. These inspection procedures will be developed specifically for each complex bridge.

Preparing for Inspection of a Complex Bridge

Before beginning a complex bridge inspection, the specific inspection procedures, bridge plans, and previous inspection report will be consulted. The procedures will be accessible to the team leader during inspection. If any special training is required, this will be identified during inspection planning and a team leader meeting the training criteria will complete the inspection. Any special equipment will be collected prior to field inspection. Communication for any access precautions will also be completed before beginning the inspection.

Inspection of a Complex Bridge

If required, the Inspection team leader must be trained for inspection of complex features and risks. Each procedure identifying complex features and risks will be followed. Document and photograph defects and conditions as directed in the procedure. Care will be taken to thoroughly inspect the complex features identified in the inspection procedure. Any additional comments or instructions will be added to the procedures during inspection to aid the next inspection. Any significant findings or defects will be discussed with the Inspection Manager and with Bridge Management Headquarters.

4.2 Inspection Assignments and Planning

4.2.1 General

Inspectors need to organize inspections to make the most efficient use of time, travel, and equipment. Ideally, the inspection workload from year to year will be divided equally, and structures in the same geographical area will be inspected together to avoid repetitious trips.

Traffic flow and density also must be considered when planning the time of day to be at the site. The inspection itself will be conducted in a safe and systematic manner that will minimize the possibility of bridge elements being overlooked.

4.2.2 Inspection Assignments

Inspection assignments are used to schedule, assign inspections, and help plan inspections. Area Bridge Inspection Managers and MDT Term Contract Managers are responsible for creating Inspection Assignments. In general, internal inspections assignments will be created for each month. For consultant inspections these assignments can be created for each term assignment or for each month, whatever is easier for the contract manger and the consultant.

For bridges that have multiple inspection types due during the same month all inspection types will need to be assigned (ex. Routine and NSTM Inspections).

The “My Assignments” tab is in Inspection -> My Assignments. This tab includes any inspections that are assigned to an inspection group that an inspector is currently part of. Any regular scheduled inspection can only be created through “My Assignments.” One-off non-scheduled inspections can be created outside of an assignment.

Tracking Inspection Assignments

After an inspection has been assigned to an inspection group it needs to be created. To view all assignments currently assigned to your inspection group go to Inspection>My Assignments. From this page you can see each assignment and the status of the inspections. The status of these inspections is broken out into four categories:

- Not Started
  - Inspections not started yet within BrM
- Entered in BrM
  - Inspections started within BrM
- In Review
  - Inspections sent for Inspection Review
- Review Complete
  - Inspections that are entered and have been reviewed

Since assignments are created for each month, you can track the status of inspections for each month. Once an inspection assignment has had all inspections reviewed it will be marked as complete and will not show in the My Assignments module unless the show completed check box is marked.

My Groups Assignments

When you open the My Assignments page, you will see all inspection assignments currently assigned to your inspection group. This will also include a summary of the status of the inspections included with each assignment.

Assignment Details

In Assignment Details you can see required equipment, inspection procedures, inspection information, and other bridge information. On the right side of the list there are four different options to choose from:

- View Inspection Equipment and Procedures
- Request Reassignment
- Start Inspection
- Request Reassignment

Request Reassignment:

This should be used if a bridge was mistakenly added to an inspection assignment and needs to be removed from it.

Creating a New Inspection:

1. Open the Assignment Details Window
2. Click on Begin Inspection
3. Fill in Inspection Details Window
   a. Inspection Begin Date Is date inspection was performed
   b. Entered By is who is doing the entry work
   c. Add New Inspection Types drop-downs for Inspection Type and Inspector

i. Only use if adding another inspection type not scheduled in the assignment

4. Click on Save at the bottom of the screen to create the inspection

4.3 Consultant Inspections

MDT contracts with consultants to perform specialty and regular inspections. MDT does not have the resources or in-house expertise to perform diving (Underwater) or climbing inspections and certain types of non-destructive testing (NDT). Consultants are also utilized when MDT resources are not available to complete all regularly scheduled inspections on time.

4.3.1 Specialty Inspections

MDT uses the following process to complete specialty consultant inspections:

- Consultants are hired using MDT's Consultant Design processes and accessis granted to BrM. See requirements below for external user access.
- The consultant performs bridge inspection.
- The inspection is entered in BrM. The consultant performs Quality Control of a specialty inspection in alignment with the MDT inspection contract provisions and completes the review steps in the Inspection Review Module.
- MDT completes administrative reviews on the inspection and inspection documents. MDT requests correction and resubmittal as necessary.
- MDT Headquarters personnel complete the review process and reports are generated by BrM into Multimedia.

4.3.2 Post-Flooding Inspection (Reserved)

4.3.3 Post Earthquake Inspection (Reserved)

4.3.4 Regular Inspections

MDT uses the following process to complete a regular inspection performed by consultants.

- Consultants are hired using MDT's Consultant Design Section processes and access is granted to the BrM. See requirements below for external user access.
- The consultant performs bridge inspection.
- The inspection is entered in BrM. The consultant performs Quality Control of a Routine Inspection in alignment with the MDT inspection contract provisions and completes the review steps in the Inspection Review Module.
- Area Bridge Inspection Manager completes administrative review of the inspection and inspection documents. MDT requests correction and resubmittal as necessary. QC and QA of consultant regular inspections follow the processes outlined above.

Chapter 4 Appendices

Appendix 4A
Post-Flood Bridge Inspection Form

Post Flood Bridge Inspection Form

Montana Department of Transportation

Bridge ID #:		Inspector(s):	
Date:		Feature Crossed:	
District:		Location Description:	
Time:			
☐ Photos Taken?	☐ Photos in BMS?	Visible Highwater Mark:	

General Status
☐ Open
☐ Open w/ restrictions
☐ Closed - need minor repair/analysis
☐ Closed - need major repair/replacement

Restrictions
☐ None
☐ Open to passenger traffic only
☐ Lane usage restriction
☐ Ext ramps used as detour

General Damage Category and Summary	
☐ No Damage	
☐ Minor Damage	
☐ Major Damage	
☐ Partial or Complete Collapse	

ELEMENTS	DAMAGE LEVEL	COMMENTS
1. Approach Roadway (Look for washouts, voids under asphalt, sideslope erosion, approach rail issues, etc...)	None ☐ Minor ☐ Major ☐	
2. Evience of Impact (Look for impact evidence or damage due to debris on superstructure and substructure)	None ☐ Minor ☐ Major ☐	
3. Abutments and Wingwalls (Note any settlement, rotation, scour, or undermining, pile damage, flood related cracking, shifting of bearings etc...)	None ☐ Minor ☐ Major ☐	
4. Piers (Note any settlement, rotation, undermining, or shifting of bearings, etc...)	None ☐ Minor ☐ Major ☐	
5. Known, Existing scour Countermeasures (Note any movement, shifting, settlement or loss of know scour countermeasures at piers or abutments)	None ☐ Minor ☐ Major ☐	
6. Rip Rap (note any settlement, slumping, or loss of pre-existing rip-rap)	None ☐ Minor ☐ Major ☐	
7. Channel alignment (Note any major channel shift or realignment)	None ☐ Minor ☐ Major ☐	
8. Debris (Note any debris caught against structure or on caps or girders, the specific bents and locations, and the type and size of debris)	None ☐ Minor ☐ Major ☐	
9. Girders/Beams (Note any debris impact damage to beams or other supersutrcure elements)	None ☐ Minor ☐ Major ☐	
10. Utilities and Other Misc. (Note any exposed or damaged utility lines or any other misc. items or concerns of note)	None ☐ Minor ☐ Major ☐	

Protection Password: MDT

Appendix 4B
Adding Special Inspections

Adding Special Inspections

Once it is determined that a Special inspection is required, it needs to be scheduled in BrM and have an inspection procedure written.

Scheduling and Procedures

There are 6 types of Special inspections you can choose from. Other Special (numbered 0 to 3), Underwater Special, and Pin and Hanger NDT. All of these inspection types roll up into the NBI Other Special inspection dates and frequency. Underwater special should be used to schedule Special underwater inspections that require diving inspectors. Pin and Hanger NDT should be used to schedule Pin and Hanger NDT inspections that require specialized NDT equipment. Other Special (0 to 3) should be used for all other cases where a special inspection is required. When scheduling Special inspections, the inspections will show up in the inspection assignments module to be added to an assignment.

Modification to Special Inspection Schedule

An Inspector may request a change in the frequency (increase or decrease) of a Special Inspection due to repairs, deterioration to a worse condition, or no change in condition for an extended amount of time. Requests may also be made to remove a Special inspection and return to a Routine inspection only. This request needs to be sent to the Bridge Inspection Engineer via email. The Bridge Inspection Engineer will have the final say on modifying or removing the Special inspection interval or process.

Appendix 4C
Earthquake Inspection Form (Reserved)

RESERVED

Appendix 4D Extended Inspection Interval Criteria (Removed 4/2026)

Appendix 4E
SNBI Items Inspector Responsibility

SNBI Item	SNBI Item Name	Inspector Responsibility	BrM Page	Page Section
B.ID.01	Bridge Number	Yes	Inventory|Appraisal > Identification	Structure Identification
B.ID.02	Bridge Name	Yes	Inventory|Appraisal > Identification	Structure Identification
B.ID.03	Previous Bridge Number	Yes	Inventory|Appraisal > Identification	Structure Identification
B.L.01	State Code	Yes	Inventory|Appraisal > Identification	Location
B.L.02	County Code	Yes	Inventory|Appraisal > Identification	Location
B.L.03	Place Code	Yes	Inventory|Appraisal > Identification	Location
B.L.04	Highway Agency District	Yes	Inventory|Appraisal > Identification	Location
B.L.05	Latitude	Yes	Inventory|Appraisal > Identification	Coordinates Table
B.L.06	Longitude	Yes	Inventory|Appraisal > Identification	Coordinates Table
B.L.07	Border Bridge Number	Yes	Inventory|Appraisal > Identification	Border Bridge
B.L.08	Border Bridge State or Country Code	No	Inventory|Appraisal > Identification	Border Bridge
B.L.09	Border Bridge Inspection Responsibility	No	Inventory|Appraisal > Identification	Border Bridge
				*does not show up if border bridge is not checked
B.L.10	Border Bridge Designated Lead State	No	Inventory|Appraisal > Identification	Border Bridge
				*does not show up if border bridge is not checked

B.L.11	Bridge Location	Yes	Inventory|Appraisal > Identification	Border Bridge
				*does not show up if border bridge is not checked
B.L.12	Metropolitan Planning Organization	Yes	Inventory|Appraisal > Identification	Data Synced from ALTIS
B.CL.01	Owner	Yes	Inventory|Appraisal > Identification	Classification
B.CL.02	Maintenance Responsibility	Yes	Inventory|Appraisal > Identification	Classification
B.CL.03	Federal or Tribal Land Access	Yes	Inventory|Appraisal > Identification	Classification
B.CL.04	Historic Significance	No	Inventory|Appraisal > Identification	Classification
B.CL.05	Toll	Yes	Inventory|Appraisal > Identification	Classification
B.CL.06	Emergency Evacuation Designation	No	Inventory|Appraisal > Identification	Classification
B.SP.01	Span Configuration Designation	Yes	Inventory|Appraisal > Design|Construction	Superstructure Set
B.SP.02	Number of Spans	Yes	Inventory|Appraisal > Design|Construction	Superstructure Set

SNBI Item	SNBI Item Name	Inspector Responsibility	BrM Page	Page Section
B.SP.03	Number of Beam Lines	Yes	Inventory|Appraisal > Design|Construction	Superstructure Set
B.SP.04	Span Material	Yes	Inventory|Appraisal > Design|Construction	Superstructure Set
B.SP.05	Span Continuity	Yes	Inventory|Appraisal > Design|Construction	Superstructure Set
B.SP.06	Span Type	Yes	Inventory|Appraisal > Design|Construction	Superstructure Set
B.SP.07	Span Protective System	Yes	Inventory|Appraisal > Design|Construction	Superstructure Set
B.SP.08	Deck Interaction	Yes	Inventory|Appraisal > Design|Construction	Superstructure Set
B.SP.09	Deck Material and Type	Yes	Inventory|Appraisal > Design|Construction	Superstructure Set
B.SP.10	Wearing Surface	Yes	Inventory|Appraisal > Design|Construction	Superstructure Set
B.SP.11	Deck Protective System	Yes	Inventory|Appraisal > Design|Construction	Superstructure Set
B.SP.12	Deck Reinforcing Protective System	Yes	Inventory|Appraisal > Design|Construction	Superstructure Set
B.SP.13	Deck Stay-In-Place Forms	Yes	Inventory|Appraisal > Design|Construction	Superstructure Set
B.SB.01	Substructure Configuration Designation	Yes	Inventory|Appraisal > Design|Construction	Substructure Set
B.SB.02	Number of Substructure Units	Yes	Inventory|Appraisal > Design|Construction	Substructure Set
B.SB.03	Substructure Material	Yes	Inventory|Appraisal > Design|Construction	Substructure Set
B.SB.04	Substructure Type	Yes	Inventory|Appraisal > Design|Construction	Substructure Set
B.SB.05	Substructure Protective System	Yes	Inventory|Appraisal >	Substructure Set

			Design|Construction	
B.SB.06	Foundation Type	Yes	Inventory|Appraisal > Design|Construction	Substructure Set
B.SB.07	Foundation Protective System	Yes	Inventory|Appraisal > Design|Construction	Substructure Set
SNBI Item	**SNBI Item Name**	**Inspector Responsibility**	**BrM Page**	**Page Section**
B.G.01	NBIS Bridge Length	Yes	Inventory|Appraisal > Geometry	Geometry
B.G.02	Total Bridge Length	Yes	Inventory|Appraisal > Geometry	Geometry
B.G.03	Maximum Span Length	Yes	Inventory|Appraisal > Geometry	Geometry
B.G.04	Minimum Span Length	Yes	Inventory|Appraisal > Geometry	Geometry
B.G.05	Bridge Width Out-to-Out	Yes	Inventory|Appraisal > Geometry	Geometry
B.G.06	Bridge Width Curb-to-Curb	Yes	Inventory|Appraisal > Geometry	Geometry
B.G.07	Left Curb or Sidewalk Width	Yes	Inventory|Appraisal > Geometry	Geometry
B.G.08	Right Curb or Sidewalk Width	Yes	Inventory|Appraisal > Geometry	Geometry
B.G.09	Approach Roadway Width	Yes	Inventory|Appraisal > Geometry	Geometry
B.G.10	Bridge Median	Yes	Inventory|Appraisal > Geometry	Geometry
B.G.11	Skew	Yes	Inventory|Appraisal > Geometry	Geometry
B.G.12	Curved Bridge	Yes	Inventory|Appraisal > Geometry	Geometry
B.G.13	Maximum Bridge Height	Yes	Inventory|Appraisal > Geometry	Geometry
B.G.14	Sidehill Bridge	Yes	Inventory|Appraisal >	Geometry

			Geometry	
B.G.15	Irregular Deck Area	Yes	Inventory|Appraisal > Geometry	Geometry
B.G.16	Calculated Deck Area	Yes	Inventory|Appraisal > Geometry	Geometry
				*Auto-calculated
B.RH.01	Bridge Railings	Yes	Inventory|Appraisal > Appraisal	Railings and Transitions
B.RH.02	Transitions	Yes	Inventory|Appraisal > Appraisal	Railings and Transitions
B.F.01	Feature Type	Yes	Features > Feature Set	Feature Details
B.F.02	Feature Location	Yes	Features > Feature Set	Feature Details
B.F.03	Feature Name	Yes	Features > Feature Set	Feature Details
B.RT.01	Route Designation	Yes	Features > Feature Set	Route Information Table
B.RT.02	Route Number	Yes	Features > Feature Set	Route Information Table
B.RT.03	Route Direction	Yes	Features > Feature Set	Route Information Table
B.RT.04	Route Type	Yes	Features > Feature Set	Route Information Table
B.RT.05	Service Type	Yes	Features > Feature Set	Route Information Table
B.H.01	Functional Classification	Yes	Features > Feature Set	Highway Information - ALTIS Data Sync
B.H.02	Urban Code	Yes	Features > Feature Set	Highway Information - ALTIS Data Sync
B.H.03	NHS Designation	Yes	Features > Feature Set	Highway Information - ALTIS Data Sync
B.H.04	National Highway Freight Network	Yes	Features > Feature Set	Highway Information - Inspector Entry
SNBI Item	**SNBI Item Name**	**Inspector Responsibility**	**BrM Page**	**Page Section**
B.H.05	STRAHNET Designation	Yes	Features > Feature Set	Highway Information - ALTIS Data Sync
B.H.06	LRS Route ID	Yes	Features > Feature Set	Highway Information - Inspector Entry
B.H.07	LRS Mile Point	Yes	Features > Feature Set	Highway Information - ALTIS Data

				Sync
B.H.08	Lanes on Highway	Yes	Features > Feature Set	Traffic - Inspection Entry
B.H.09	Annual Average Daily Traffic	Yes	Features > Feature Set	Traffic - ALTIS Data Sync
B.H.10	Annual Average Daily Truck Traffic	Yes	Features > Feature Set	Traffic - ALTIS Data Sync
B.H.11	Year of Annual Average Daily Traffic	Yes	Features > Feature Set	Traffic - ALTIS Data Sync
B.H.12	Highway Maximum Usable Vertical Clearance	Yes	Features > Feature Set	Clearances
B.H.13	Highway Minimum Vertical Clearance	Yes	Features > Feature Set	Clearances
B.H.14	Highway Minimum Horizontal Clearance, Left	Yes	Features > Feature Set	Clearances
B.H.15	Highway Minimum Horizontal Clearance, Right	Yes	Features > Feature Set	Clearances
B.H.16	Highway Maximum Usable Surface Width	Yes	Features > Feature Set	Clearances
B.H.17	Bypass Detour Length	Yes	Features > Feature Set	Detours
B.H.18	Crossing Bridge Number	Yes	Features > Feature Set	Crossing Bridge
				*Only shows up if Feature Type = Highway and Feature Location = Above bridge or Below bridge
B.RR.01	Railroad Service Type	Yes	Features > Feature Set	Railroad Details
				*Only shows up if Feature Type = Railroad
B.RR.02	Railroad Minimum Vertical Clearance	Yes	Features > Feature Set	Railroad Details
				*Only shows up if Feature Type = Railroad

SNBI Item	SNBI Item Name	Inspector Responsibility	BrM Page	Page Section
B.RR.03	Railroad Minimum Horizontal Offset	Yes	Features > Feature Set	Railroad Details
				*Only shows up if Feature Type = Railroad
B.N.01	Navigable Waterway	No	Features > Feature Set	Waterway Details
				*Only shows up if Feature Type = Waterway
B.N.02	Navigation Minimum Vertical Clearance	No	Features > Feature Set	Waterway Details
				*Only shows up if Feature Type = Waterway
B.N.03	Movable Bridge Maximum Navigation Vertical Clearance	No	Features > Feature Set	Waterway Details
				*Only shows up if Feature Type = Waterway
B.N.04	Navigation Channel Width	No	Features > Feature Set	Waterway Details
				*Only shows up if Feature Type = Waterway
B.N.05	Navigation Channel Minimum Horizontal Clearance	No	Features > Feature Set	Waterway Details
				*Only shows up if Feature Type = Waterway
B.N.06	Substructure Navigation Protection	No	Features > Feature Set	Waterway Details
				*Only shows up if Feature Type = Waterway
B.LR.01	Design Load	No	Inventory|Appraisal > Design|Construction	Design|Construction Information
B.LR.02	Design Method	No	Inventory|Appraisal > Design|Construction	Design|Construction Information
B.LR.03	Load Rating Date	No	Load Rating > Load Ratings	Load Rating Event
B.LR.04	Load Rating Method	No	Load Rating > Load Ratings	Load Rating Event

B.LR.05	Inventory Load Rating Factor	No	Load Rating > Load Ratings	Load Rating Event
B.LR.06	Operating Load Rating Factor	No	Load Rating > Load Ratings	Load Rating Event
B.LR.07	Controlling Legal Load Rating Factor	No	Load Rating > Load Ratings	Load Rating Event
B.LR.08	Routine Permit Loads	No	Load Rating > Load Rating Admin	Additional Load Rating Info
B.PS.01	Load Posting Status	No	Load Posting > Load Posting Status	Load Posting Event
SNBI Item	**SNBI Item Name**	**Inspector Responsibility**	**BrM Page**	**Page Section**
B.PS.02	Posting Status Change Date	No	Load Posting > Load Posting Status	Load Posting Event
B.EP.01	Legal Load Configuration	No	Load Rating > Load Ratings	Load Rating Event
B.EP.02	Legal Load Rating Factor	No	Load Rating > Load Ratings	Load Rating Event
B.EP.03	Posting Type	No	Load Posting > Load Posting Status	Load Posting Event - Sign Type
B.EP.04	Posting Value	No	Load Posting > Load Posting Status	Load Posting Event - Sign Type
B.IR.01	NSTM Inspection Required	Yes	Schedule	Inspection Needs
B.IR.02	Fatigue Details	Yes	Schedule	Inspection Needs
B.IR.03	Underwater Inspection Required	Yes	Schedule	Inspection Needs
B.IR.04	Complex Feature	Yes	Schedule	Inspection Needs
B.IE.01	Inspection Type	Yes	Schedule	Schedule Table
B.IE.02	Inspection Begin Date	Yes	Schedule	Inspection Summary
B.IE.03	Inspection Completion Date	Yes	Schedule	Inspection Summary/Schedule Table
B.IE.04	Nationally Certified Bridge Inspector	Yes	n/a	Assigned by BrM in Security - Users - License
B.IE.05	Inspection Interval	Yes	Schedule	Schedule Table
B.IE.06	Inspection Due Date	Yes	Schedule	Schedule Table
B.IE.07	Risk-Based Inspection Interval Method	Yes	Schedule	Schedule Table
B.IE.08	Inspection Quality Control Date	Yes	Schedule	Inspection Summary
B.IE.09	Inspection Quality Assurance Date	Yes	Schedule	Inspection Summary
B.IE.10	Inspection Data Update Date	Yes	Schedule	Inspection Summary
B.IE.11	Inspection Note	Yes	Inspection > Condition	Limited Inspection Notes
B.IE.12	Inspection Equipment	Yes	Inspection > Future Inspection Plan > Equipment	

B.C.01	Deck Condition Rating	Yes	Inspection > Condition	Condition Ratings
B.C.02	Superstructure Condition Rating	Yes	Inspection > Condition	Condition Ratings
B.C.03	Substructure Condition Rating	Yes	Inspection > Condition	Condition Ratings
B.C.04	Culvert Condition Rating	Yes	Inspection > Condition	Condition Ratings
B.C.05	Bridge Railing Condition Rating	Yes	Inspection > Condition	Condition Ratings
B.C.06	Bridge Railing Transitions Condition Rating	Yes	Inspection > Condition	Condition Ratings
B.C.07	Bridge Bearings Condition Rating	Yes	Inspection > Condition	Condition Ratings
B.C.08	Bridge Joints Condition Rating	Yes	Inspection > Condition	Condition Ratings

SNBI Item	SNBI Item Name	Inspector Responsibility	BrM Page	Page Section
B.C.09	Channel Condition Rating	Yes	Inspection > Condition	Condition Ratings
B.C.10	Channel Protection Condition Rating	Yes	Inspection > Condition	Condition Ratings
B.C.11	Scour Condition Rating	Yes	Inspection > Condition	Condition Ratings
B.C.12	Bridge Condition Classification	No	Inspection > Condition	Condition Ratings
				*Auto-calculated
B.C.13	Lowest Condition Rating Code	No	Inspection > Condition	Condition Ratings
				*Auto-calculated
B.C.14	NSTM Inspection Condition	Yes	Inspection > Condition	Condition Ratings
B.C.15	Underwater Inspection Condition	Yes	Inspection > Condition	Condition Ratings
B.AP.01	Approach Roadway Alignment	Yes	Inventory|Appraisal > Appraisal	Appraisal
B.AP.02	Overtopping Likelihood	Yes	Inventory|Appraisal > Appraisal	Appraisal
B.AP.03	Scour Vulnerability	Yes	Inventory|Appraisal > Appraisal	Appraisal
B.AP.04	Scour Plan of Action		Inventory|Appraisal > Appraisal	Appraisal
B.AP.05	Seismic Vulnerability		Inventory|Appraisal > Appraisal	Appraisal
B.W.01	Year Built		Inventory|Appraisal > Design|Construction	Design|Construction Information
B.W.02	Year Work Performed		Inventory|Appraisal > Design|Construction	Work Events for Bridge
B.W.03	Work Performed		Inventory|Appraisal > Design|Construction	Work Events for Bridge

Appendix 4F
MDT Items Inspector Responsibility

Item No.	Name	Inspector Responsible	BrM Input Tab	Tab Sub-Group	Notes
MDT007	Departmental Route	Yes	Features	Route Information	
MDT008	Depth of Cover	Yes	Inspection > Condition	Load Rating Info	
MDT009	Bypass Average Speed	Yes	Features	Additional Highway Info > Detours	
MDT010	NSTM Details	Yes	Inventory|Appraisal > Design|Construction	Design |Construction Information	
MDT014	Interchange Indicator	Yes	Inventory|Appraisal > Identification	MDT Fields - Inspector Entry	
MDT015	Interstate Ramp Indicator	Yes	Inventory|Appraisal > Identification	MDT Fields - Inspector Entry	
MDT016	Load Rating Date	No	Load Rating > Load Rating Admin	Load Rating Planning	Do not add to manual text: See Load rating engineer
MDT017	MDT Original Construction Project Number	Yes	Inventory|Appraisal > Design|Construction	Original Construction	
MDT018	MDT Original Construction Station	Yes	Inventory|Appraisal > Design|Construction	Original Construction	
MDT019	MDT Original Drawing Number	Yes	Inventory|Appraisal > Design|Construction	Original Construction	
MDT020	MDT Maintenance Division	Yes	Inventory|Appraisal > Identification	MDT Fields - Inspector Entry	
MDT021	MDT Original UPN	Yes	Inventory|Appraisal > Design|Construction	Original Construction	
MDT022	Name of Load Rater	No	Load Rating > Load Rating Admin	Load Rating Planning	Do not add to manual text: See Load rating engineer
MDT027	On | Off System	Yes	Inventory|Appraisal > Identification	MDT Fields - Inspector Entry	

Item No.	Name	Inspector Responsible	BrM Input Tab	Tab Sub-Group	Notes
MDT030	Route Speed (MPH)	Yes	Features	Traffic > Inspector Entry	
MDT031	Railroad Over|Underpass	Yes	Inventory|Appraisal > Identification	MDT Fields - Inspector Entry	
MDT032	Railroad Owner	Yes	Inventory|Appraisal > Identification	MDT Fields - Inspector Entry	
MDT034	Request Review of Load Rating	Yes	Inspection > Condition	Load Rating Info	
MDT059	TE Route	Yes	Features	Route Information	
MDT074	Underwater	No	Schedule	Specialized Inspection	
MDT078	MDT Maintenance Section	Yes	Inventory|Appraisal > Identification	MDT Fields - Inspector Entry	
MDT087	Decimal Mile Post	Yes	Features	Additional Highway Info > Mile Post	
MDT090	Climbing Inspection Required	No	Schedule	Specialized Inspection	
MDT097	Plans in BrM	Yes	Inventory|Appraisal > Design|Construction	Design |Construction Information	
MDT098	Shop Drawings in BrM	Yes	Inventory|Appraisal > Design|Construction	Design |Construction Information	
MDT099	MDT Rehab Project Number	Yes	Inventory|Appraisal > Design|Construction	Rehab	
MDT100	MDT Rehab Stations	Yes	Inventory|Appraisal > Design|Construction	Rehab	
MDT101	MDT Rehab UPNs	Yes	Inventory|Appraisal > Design|Construction	Rehab	
MDT102	Years Rehab	Yes	Inventory|Appraisal > Design|Construction	Design |Construction Information	
MDT103	MDT Rehab Drawing Numbers	Yes	Inventory|Appraisal > Design|Construction	Rehab	

Item No.	Name	Inspector Responsible	BrM Input Tab	Tab Sub-Group	Notes
MDT110	Bridge Being Rated by Consultant	No	Load Rating > Load Rating Admin	Load Rating Planning	Do not add to manual text: See Load rating engineer
MDT113	Station Mile Post	Yes	Features	Additional Highway Info > Mile Post	
MDT115	MDT Administrative District	No	Inventory|Appraisal > Identification	Data Synced from ALTIS	
MDT116	MDT Financial District	No	Inventory|Appraisal > Identification	Data Synced from ALTIS	
MDT117	Neighboring County Code	Yes	Inventory|Appraisal > Identification	MDT Fields - Inspector Entry	
MDT118	Underwater Consultant	No	Schedule	Specialized Inspection	
MDT119	Date Bridge Opened|ReOpened	Yes	Inventory|Appraisal > Design|Construction	Design |Construction Information	
MDT133	Reasonable Access of Interstate	Yes	Inventory|Appraisal > Identification	MDT Fields - Inspector Entry	
MDT145	Bridge Inventory Direction	Yes	Inventory|Appraisal > Identification	MDT Fields - Inspector Entry	
MDT146	Bridge with a Reservation Boundary	No	Inventory|Appraisal > Identification	Data Synced from ALTIS	
MDT149	Consultant Regular Inspection	No	Schedule	Specialized Inspection	
MDT150	Scour Evaluation Started	No	Inventory|Appraisal > Appraisal	Scour > Scour Evaluation Tracking	
MDT151	Scour Evaluation Completed	No	Inventory|Appraisal > Appraisal	Scour > Scour Evaluation Tracking	
MDT152	Sent to USGS	No	Inventory|Appraisal > Appraisal	Scour > Scour Evaluation Tracking	
MDT153	Sent to Hydraulics	No	Inventory|Appraisal > Appraisal	Scour > Scour Evaluation Tracking	

Item No.	Name	Inspector Responsible	BrM Input Tab	Tab Sub-Group	Notes
MDT154	Structure Risk Level - Scour	No	Inventory|Appraisal > Appraisal	Scour > Scour Evaluation Tracking	
MDT155	Year Reconstructed	Yes	Inventory|Appraisal > Design|Construction	Design |Construction Information	
MDT156	Uncoated Weathering Steel	Yes	Inventory|Appraisal > Design|Construction	Design |Construction Information	
MDT157	Trigger Flow	No	Inventory|Appraisal > Appraisal	Scour > Scour Plan of Action References	*Entered and maintained by Hydraulics - included in MV2 and used for Scour website and notifications*
MDT158	Gage Site	No	Inventory|Appraisal > Appraisal	Scour > Scour Plan of Action References	*Entered and maintained by Hydraulics - included in MV2 and used for Scour website and notifications*
MDT159	Real Time Gage Link	No	Inventory|Appraisal > Appraisal	Scour > Scour Plan of Action References	
MDT160	NWS Streamflow Forecast Link	No	Inventory|Appraisal > Appraisal	Scour > Scour Plan of Action References	
MDT161	QA Reviewer	No	Inspection > Inspection QA	Inspection QA	
MDT162	Abutment Encroachment Floodplain	Yes	Inspection > Condition	Probe and Wade	
MDT163	Amount of Channel Constriction	Yes	Inspection > Condition	Probe and Wade	
MDT164	Pier Nose Shape	Yes	Inspection > Condition	Probe and Wade	
MDT165	Angle of Attack	Yes	Inspection > Condition	Probe and Wade	
MDT166	Potential Debris Accumulation	Yes	Inspection > Condition	Probe and Wade	
MDT167	Pier Width	Yes	Inspection > Condition	Probe and Wade	

Item No.	Name	Inspector Responsible	BrM Input Tab	Tab Sub-Group	Notes
MDT168	Bed Material	Yes	Inspection > Condition	Probe and Wade	
MDT169	Flow Impinging	Yes	Inspection > Condition	Probe and Wade	
MDT170	Bridge Location at Stream Bend	Yes	Inspection > Condition	Probe and Wade	
MDT171	Constriction Channel Vegetation	Yes	Inspection > Condition	Probe and Wade	
MDT172	Number of Piers	Yes	Inspection > Condition	Probe and Wade	
MDT173	Bridge Near a Stream Confluence	Yes	Inspection > Condition	Probe and Wade	
MDT174	Probe and Wade Comments	Yes	Inspection > Condition	Probe and Wade	
MDT175	MDT Route System	No	Features	Highway Information > Altis Data Sync	
MDT176	Temperature	Yes	Schedule	Inspection Summary	
MDT177	Weather	Yes	Schedule	Inspection Summary	
MDT178	BNSF RR Flagger Required	Yes	Schedule	Specialized Inspection	
MDT179	MDT ID	No	Inventory|Appraisal > Identification	Structure Identification	
MDT180	Bridge Status	Yes	Inventory|Appraisal > Identification	Structure Identification	
MDT181	Report Elements to FHWA	Yes	Inventory|Appraisal > Identification	Structure Identification	
MDT182	Facility Carried	Yes	Inventory|Appraisal > Identification	Location	
MDT183	Feature Intersected	Yes	Inventory|Appraisal > Identification	Location	
MDT184	Nickname	No	Inventory|Appraisal > Identification	Location	*calculated field ([*Facility Carried] OVER [Feature Intersected]*)

Item No.	Name	Inspector Responsible	BrM Input Tab	Tab Sub-Group	Notes
MDT185	LRS Data as of Date	No	Features	Highway Information > Altis Data Sync	
MDT186	Percent Truck Traffic	No	Features	Traffic > Altis Data Sync	Calculated field - appears to calculate when traffic data is saved
MDT187	Future AADT	No	Features	Traffic > Altis Data Sync	
MDT188	Year of Future AADT	No	Features	Traffic > Altis Data Sync	
MDT189	Railroad Bridge Agency Bridge ID	No	Features	Railroad Details	
MDT190	Date Entered	Yes	Schedule	Inspection Summary	
MDT191	Entered by	Yes	Schedule	Inspection Summary	
MDT192	Is Posting Required?	No	Load Posting > Load Posting Requirements		Do not add to manual text: See Load rating engineer
MDT193	Load Posting Authorization Date	No	Load Posting > Load Posting Requirements		Do not add to manual text: See Load rating engineer
MDT194	Required Posting Sign Type	No	Load Posting > Load Posting Requirements		Do not add to manual text: See Load rating engineer
MDT195	Required R12-1: Gross Posting (tons)	No	Load Posting > Load Posting Requirements		Do not add to manual text: See Load rating engineer
MDT196	Required R12-5: Type 3 Truck Posting (tons)	No	Load Posting > Load Posting Requirements		Do not add to manual text: See Load rating engineer
MDT197	Required R12-5: Type 3S2 Truck Posting (tons)	No	Load Posting > Load Posting Requirements		Do not add to manual text: See Load rating engineer
MDT198	Required R12-5: Type 3-3 Truck Posting (tons)	No	Load Posting > Load Posting Requirements		Do not add to manual text: See Load rating engineer
MDT199	Required R12-6: 2-7 axles Posting (tons)	No	Load Posting > Load Posting Requirements		Do not add to manual text: See Load rating engineer

Item No.	Name	Inspector Responsible	BrM Input Tab	Tab Sub-Group	Notes
MDT200	Required R12-6: 4-7 axles Posting (tons)	No	Load Posting > Load Posting Requirements		Do not add to manual text: See Load rating engineer
MDT201	Required R12-6: 5-7 axles Posting (tons)	No	Load Posting > Load Posting Requirements		Do not add to manual text: See Load rating engineer
MDT202	Required R12-6: 6-7 axles Posting (tons)	No	Load Posting > Load Posting Requirements		Do not add to manual text: See Load rating engineer
MDT203	Required R12-6: 7 axles Posting (tons)	No	Load Posting > Load Posting Requirements		Do not add to manual text: See Load rating engineer
MDT204	Required R12-7 or R12-7aP: Single Axle Posting (tons)	No	Load Posting > Load Posting Requirements		Do not add to manual text: See Load rating engineer
MDT205	Required R12-7 or R12-7aP: Tandem Axle Posting (tons)	No	Load Posting > Load Posting Requirements		Do not add to manual text: See Load rating engineer
MDT206	Required R12-7 or R12-7aP: Gross Posting (tons)	No	Load Posting > Load Posting Requirements		Do not add to manual text: See Load rating engineer
MDT207	MDT Posting Status Description	No	Load Posting > Load Posting Status	Heading	Do not add to manual text: See Load rating engineer

Chapter 5 – Inspection Procedures

5.1 Introduction

On December 15, 1967, the Silver Bridge over the Ohio River in West Virginia collapsed due to a fractured eyebar, killing 46 people. The tragedy prompted Congress to enact the Federal-Aid Highway Act of 1968 initiating the National Bridge Inspection Standards (NBIS). By law, the states were now required to inspect all Federal-Aid System bridges on a regular two-year interval.

Ten years later, the Surface Transportation Assistance Act expanded the NBIS to include bridges on all public roads. From this point on, each state was responsible for the inspection of all bridges within its borders including those under county jurisdiction.

The 1983 failure of the Mianus River Bridge in Greenwich, Connecticut was caused by the failure of one pin and hanger assembly in a two-girder span which then caused the other pin and hanger to be overloaded resulting in a suspended span falling into the river below. The failure killed three people and severely injured three others. The FHWA immediately required a hands-on inspection of all similar assemblies on fracture critical bridges, which are now known as nonredundant steel tension member (NSTM) bridges.

This set the wheels in motion for extensive changes to the national bridge inspection program. The 1988 Revision to the NBIS required each state to:

1. Develop master lists of all bridges having fracture critical members (NSTMs).
2. Establish procedures for the inspection of those members.
3. Determine the frequency of those inspections.

The two bridge failures mentioned above had one similarity; both were almost instantaneous collapses brought on by the failure of nonredundant steel tension members.

Then in 2007, an undersized gusset plate led to the failure of the I-35W deck truss bridge in Minneapolis, Minnesota, bringing the inspection and load rating of gusset plates in truss bridges to the forefront. The undersized gusset plate failed while the bridge was under rehabilitation, partially due to the additional weight of construction materials stored on the bridge. Thirteen people died, and over 100 people were injured due to the failure. This collapse also brought a critical review of the National Bridge Inspection Program (NBIP) from the Inspector General and established the FHWA 23 metrics that are in use today for reviewing and verifying the adequacy of state bridge management and inspection programs.

5.2 Critical Finding Guidance

During inspections, an inspector may come across a defect that is much more serious than others. These defects are called critical findings. The *Code of Federal Regulations Title 23, Subpart C, 650.305* defines Critical Findings:

A Critical Finding is a structural or safety related deficiency that requires immediate action to ensure public safety.

Overview

Critical Findings are documented in the Critical Findings Tab in BrM. Only engineers in the Bridge Management Section Headquarters office who are licensed as a Professional Engineer can *officially* designate an issue as a Critical Finding in BrM. These personnel are typically the Bridge Inspection

Program Manager (Inspection Engineer), Load Rating Engineers, Maintenance Engineers, and Quality Assurance Engineers.

Critical Findings are to be documented on State- and non-State-owned structures.

Procedure

The following procedures will be followed when a suspected Critical Finding is discovered:

1. The inspection Team Leader will immediately contact an engineer in the Bridge Management section Headquarters office to make a verbal notification and discuss. After contacting an engineer and verbally notifying, follow up with an email documenting the discussion. If you are unsure whether something is a Critical Finding, an engineer can help make that determination when you call Headquarters. If you feel the bridge needs to be closed immediately because of imminent danger to the public, contact the Montana Highway Patrol or Sheriff's office for assistance.

   The call-down list for MDT Headquarters is located on the MDT Bridge Inspection Teams channel. Consultants contact the Bridge Inspection Engineer for a copy.

Roles and Responsibilities

1 After the Team Leader verbally contacts an engineer at Headquarters, it is the engineer's responsibility to officially declare a critical finding. The Engineer is also responsible for contacting or delegating contact of the appropriate personnel to coordinate closure, restrictions, or other necessary actions.

- The appropriate personnel may include one or more of the following entities: the local MDT Maintenance Chief and/or MDT Maintenance Superintendent, or the appropriate County or City personnel for non-State-owned-structures.

2 If someone in the Headquarters office cannot be verbally reached in a timely manner, and in the Team Leader's judgement, an immediate closure is necessary because of an acute and immediate or imminent condition that endangers the traveling public, follow the procedure below:

- Document the finding and send email and text or voicemail notifications to all Bridge Management section personnel and their cell phones.
- Contact the local MDT Maintenance Chief and/or MDT Maintenance Superintendent, or the appropriate County or City personnel for non-State-owned structures, to ensure appropriate traffic control is installed. Inform them of the urgency of the situation and whether the situation is urgent enough to require the immediate assistance of the MHP or Sheriff.

Documenting the Finding

- Send photos by text to cell phones or work e-mail for discussion.
- If found during an inspection, document the issue or defect in the element description.
- When documenting a new issue create a work candidate in BrM using the appropriate action. Set the priority to "High" and add comments.
    - Take plenty of photos of the issue
    - Document the location of the issue
    - Take measurements of the element or defect

Examples of Critical Findings

- Large cracks in steel girders
- New, unarrested cracks in the tension zone of any NSTM
- Buckling or major out of plane distortion of truss compression members
- Major impacts to steel or prestressed girders
- Missing, severely damaged, or failed timber piles
- Failed timber caps
- Holes in timber decks that are large enough to catch a tire or any hole in concrete decks
- Settlement of a bridge pier or abutment
- Approach roadway voids in the travel way (this is not really a bridge issue, but we treat it the same as a Critical Finding)
- Scour on a "Probe and Wade" inspection that indicates loss of bearing under a large portion of the footing
- Any other damage or deterioration to an element that severely impacts the capacity or stability of a structure or culvert or endangers the traveling public

5.3 Nonredundant Steel Tension Member Inspection

The Federal Highway Administration requires that all structures that have Nonredundant Steel Tension Members (NSTMs) must receive hands-on inspections. The structures that require these inspections are identified in the SNBI coding of Item B.IR.01 - NSTM Inspection Required.

To truly understand what we are trying to accomplish with this type of inspection, we must understand the fundamentals involved. 23 CFR 650.305 defines a Nonredundant Steel Tension member (NSTM) as: A primary steel member fully or partially in tension, and without load path redundancy, system redundancy or internal redundancy, whose failure may cause a portion of or the entire bridge to collapse.

By this definition, a Nonredundant Steel Tension Member is a bridge element which performs a function absolutely essential to the stability of the bridge. A NSTM is one whose function or load path cannot be redistributed and replaced by any other component of the structure.

The purposes of a nonredundant steel tension member inspection:

1. Clearly identify a bridge's Nonredundant Steel Tension members.
2. Inspect for flaws in a bridge's Nonredundant Steel Tension members.
3. Document flaw locations and conditions for accurate reporting and swift repair.

The importance of a thorough inspection of Nonredundant Steel Tension members cannot be over-emphasized.

- A NSTM bridge inspection begins before the bridge inspection crew arrives at the bridge. The crew will study the bridge's history in the inspection file and the NSTM Inspection Plan while still in the office. It is important for each inspector to understand which members are NSTM and where the NSTM zones are located. Each bridge requiring a NSTM inspection has an Inspection Plan with a superstructure plan layout with NSTM areas marked and the bridge-specific NSTM Members identified. This plan will be taken into the field for the inspection. The bridge-specific NSTM Inspection Plans have been prepared by Bridge Management Headquarters personnel or a consultant and are available in the BrM Multimedia -> Bridge -> Procedures folder. They include any previous defect/damage notes, repair notes, and fatigue-prone details along the members. BrM also has shop and construction drawings showing the NSTM members for almost all State-owned bridges and quite a few county-owned bridges. These are available in Multimedia -> Bridge -> Plans Shops and Measurements. In most cases it is desirable to perform the NSTM inspection in conjunction with the Routine element level inspection.

- For NSTM bridges new to the inventory, an Inspection Plan will be created prior to field work commencing. This specific plan will include the specific risk factors described below. See the NSTM Inspection Plan Template in Appendix 9A for Items that are included in the Plan.

5.3.1 General Procedures for Nonredundant Steel Tension Member Risk Factors

Each Bridge-specific Inspection Plan and Procedure document will include the specific NSTM risk factors. The process for identifying these risk factors and for performing inspections for risk factors is outlined in this chapter. Additional resources for NSTM inspection and identifying risk factors are in the NHI course and handbook, Bridge Inspection Techniques for Nonredundant Steel Tension Members (NSTM).

These Risk factors Include:

- Fatigue and Fracture prone details
  - Fatigue and Fracture prone details will be identified by careful reading of the bridge plans and by hands-on inspection of the structure. These details will be noted in the Bridge-specific Inspection Plan. These details are described later in this chapter and in the most recent version of the LRFD Bridge Design Specifications (Chapter 6).
- Problematic Features
  - Problematic features will be identified and noted through hands-on inspection with thorough knowledge of NSTMs and Fatigue concepts.
- Poor welding techniques
  - Poor welding techniques will be identified through hands-on inspection and noted in the Bridge-specific Inspection Plan. Examples of poor welds and potential failure resulting from them can be found in the Bridge Inspection Techniques for NSTMs handbook.
- Potential out-of-plane distortion details
  - Potential out-of-plane distortion details will be identified by careful reading of the bridge plans and by hands-on inspection of the structure.
- Previous crack repairs
  - Previous crack repairs will be noted in the Bridge-specific Inspection Plan. These repairs will be identified by hands-on inspection, comparison with rehabilitation as-built plans, and reviewing bridge historical information in BrM.
- Source of prior cracking
  - The source of prior cracking on identical or similar bridges will be identified by careful reading of the bridge plans, comparison with prior cracking sites, and by hands-on inspection of the structure.
- Cold service repairs

Cold service repairs will be documented in the Bridge-specific Inspection Plan. These repairs will be identified by hands-on inspection, by comparison with Rehabilitation as-built plans, and by reviewing bridge historical information in BrM Multimedia and the Bridge Files.

- Load Posting
  - Load posting is determined by load rating. Review the load rating to identify details controlling the load rating. These details will be noted in the Bridge-specific Inspection Plan.
- Superstructure condition code of 4 or less
  - Defects causing a superstructure rating of 4 or less will be noted in the Bridge-specific Inspection Plan.
- Subject to overloads or impact damage
  - Damage due to overloads or impact damage will be noted in the Bridge-specific Inspection Plan.
- Older service life
  - The service life will be considered throughout inspection of a bridge. Older bridges are subject to rapid deterioration and are more suspectable to damage. Defects due to long service life will be noted in the Bridge-specific Inspection Plan.
- High ADTT
  - Very few bridges in Montana have high ADTT. Greater chance of fatigue damage due to High Traffic volume will be considered throughout the inspection. Details susceptible to and Defects due to high traffic volume will be noted in the Bridge-specific Inspection Plan.
- Corrosion
  - An NSTM can be endangered by corrosion, which can lead to loss of section, pack rust, and reduced fatigue life. Proper maintenance and painting can reduce this problem. Rust can build up between plates and add additional stress to members and connections.

5.3.2 Nonredundant Steel Tension Member Inspections

- Nonredundant Steel Tension Member inspections will commence following the procedures prescribed in the NSTM Bridge Inspection Procedure. While the hands-on access requirement is the same for all NSTMs, the bridge elements vary greatly from bridge to bridge and can range from welded steel box girders to forged truss eyebars. Note that not all members on a bridge containing NSTMs are considered NSTMs. Compression members on NSTM bridges do not require the same level of hands-on inspection effort that the tension members warrant. However, compression members may need to be investigated further if any unusual conditions are identified. Inspectors should plan their inspections according to each bridge's Inspection Plan and Section 5.7 for NSTM inspection and documentation requirements for various types of superstructures with NSTMs.
- If further investigation of a defect with NDT is needed, contact Bridge Management Headquarters for coordination and scheduling.
- Inspection Procedures for Truss Bridges, Two-Girder Systems, Transverse Girders, Cross Beams, Steel Bent Caps, and Pin and Hanger Assemblies are included in subsequent Chapter 5 sections and the NHI Bridge Inspection Techniques for NSTMs handbook.

5.3.3 Nonredundant Steel Tension Member Inspection Reports

- By definition, Nonredundant Steel Tension Member bridge failures may result in partial or total collapse of the bridge. Thus, it is important that the inspection of a Nonredundant Steel Tension Member bridge be documented thoroughly and accurately. This effort will include a description of all NSTMs as shown in the NSTM Inspection Plan with problem areas noted.
- The importance of these inspections cannot be overstated. Inspectors are looking for flaws in members which are vital to the integrity of the bridge. Along with stating the existing condition, the inspection report will provide an ongoing record of the condition of the bridge. Occasionally there will be serious flaws that cannot be seen by the inspector. These should be noted in the inspection.
- NSTM Inspections are scheduled in BrM at a 24-month Frequency as the NSTM Inspection type. The NSTM type inspection will be combined with the Routine type when they are performed at the same time. The updated NSTM Inspection Procedure will be uploaded to the Multimedia Inspection Folder as a PDF document and flagged to be included in the report. This updated plan will also be saved as a Word document in the Multimedia -> Bridge -> Procedures folder, with the date of the current inspection. This plan can then be retrieved and updated at the next NSTM inspection.
- Refer to Appendix 9A and Section 5.7 for Nonredundant Steel Tension Member documentation requirements for various types of superstructures with NSTMs.

5.4 Fatigue, Stress and Redundancy

In most instances, a crack is not the result of a single load overstressing the element to the point of failure. Generally, it is caused by the repeated application of tensile loads and load reversals, which do not stress the member to anywhere near the yield point. Cracking which occurs under these circumstances is known as fatigue cracking.

A member whose state of stress at rest or under pure dead load is far different than the live load stress is very susceptible to fatigue. A good example of this are counters in a truss. The dead load stress in a counter is almost negligible, while under live load they carry a very high tensile stress. The large differential in the range of stresses these members experience during a stress cycle make them very vulnerable to fatigue cracking.

Fatigue has very little to do with the maximum stress a bridge member will encounter during its lifetime. The real issue is the range between the lower and upper limits of its stress cycle. The larger the range, the more likely fatigue will be an issue.

5.4.1 Fatigue

Fatigue-prone details can handle only so many loading cycles before cracking occurs. Cracking of fatigue-prone details in redundant steel members normally would not cause a bridge to collapse. However, if cracking occurs in a nonredundant steel member in tension, the bridge does not have any built-in ability to shift the load to other members, and the bridge may collapse.

Fatigue happens to members in tension and members exposed to cycles of out-of-plane bending. Repetitive tensile and out-of-plane forces can initiate cracks that may propagate and lead to fracture if not identified and addressed. Tension can cause cracks to grow until the member fractures. A member in axial tension is stressed the same throughout the cross-section for the total length between connections. Hangers, suspension cables, and some truss members normally are stressed in axial tension. Direct tension members, even though they may have no welding associated with them, are the most critical because they are usually used in situations where limited redundancy exists, and defects can initiate and grow to critical flaw size quickly. Eyebars and hangers that have been repaired by field welding are highly susceptible to fatigue cracking.

Any sudden change in the geometry of a structural member's cross-section can lead to a stress concentration (cover plate ends, coped webs/flanges at connections, gouges, etc.). These changes in geometry are referred to as stress risers. Bolt holes, rivet holes and many commonly used fabrication details are also stress risers and are subject to fatigue. The bridge inspector must be able to identify stress risers and spot flaws before they reach critical flaw size. Most cracks found in the field are in the vicinity of a geometric stress riser.

Many of the problems being discovered with in-service bridges are associated with weld terminations or weld defects, which are inherent to the welding process. Welding of structures generally started in the 1950s. It is very likely that fatigue-prone flaws are present in steel structures from this period due to the infancy of the welding process and weld inspection procedures in place back then. Welds made in the field are especially susceptible to fatigue cracking, especially tack welds. Though not harmful by themselves, they are very small areas that create large stress risers and will cause cracking in areas of high-tension stress or stress reversal (fatigue).

Steel details are categorized by their ability to resist cracking due to fatigue. As such, steel details are placed into Fatigue Categories that range from A to E'. Fatigue Category A is the most resistant to fatigue cracking, whereas Fatigue Category E' is the least resistant to fatigue cracking. Fatigue Categories are discussed below. While there are numerous steel fatigue references available, the following two references are recommended for bridge inspection:

- Purdue University's Fatigue and Fracture Library for the Inspection, Evaluation and Repair of Vehicular Steel Bridges
  https://docs.lib.purdue.edu/cgi/viewcontent.cgi?article=1000&context=sbritereports
- The most recent edition of the AASHTO LRFD Bridge Design Specifications (chapter 6). An electronic copy of this publication is available through the MDT library.

Both references clearly present the different fatigue categories found on steel bridges through the use of illustrations, photos and descriptions. Both references also instruct the inspector as to where cracking may occur along various steel details. The Purdue publication is written as a supplement to the fatigue detail categories in the AASHTO design manual and has detailed photo examples of many fatigue categories. Refer to these manuals for fatigue-prone information and to identify and categorize fatigue-prone details found on Montana's bridges.

5.4.2 Stress

An overview of the stresses a bridge member experiences will help in locating zones of tension stress. A load applied to any structural member will cause a force or moment, which is resisted by the entire cross-sectional area of the member. This distributing of the force or moment over the cross-sectional area is known as a stress distribution.

Axial Stress

A force whose line of action acts through a member's centroidal axis causes axial stresses. There are two types of axial forces:

Tension: the force which, when applied, tends to pull the member apart

Compression: the force which, when applied, tends to squeeze or contract the member.

Axial forces are resisted by a stress distribution of equal intensity over the entire cross section of the member.

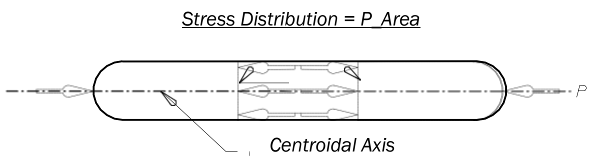


Figure 5.4-1 Axial stress distribution example.

Bending and Shear Stresses

As opposed to axial stresses, which are caused by forces applied along the length of the member, bending deals with stresses due to forces acting transversely to the member. Here we are dealing with beams. A beam is a slender member (relative to its length) that is subjected to a transverse gravity load.

Members in bending have variable stresses throughout. On a simple beam, the maximum tension is in the bottom flange at midspan. An equally important location on a continuous span is the top flange over the support. High stress may also be concentrated at locations along a member where the cross-section changes or where there is a discontinuity.

Consider the simple beam, shown supporting a weight “P” at midspan. This loading configuration causes the beam to deflect downward. As a result, the bottom of the beam is being stretched or pulled and is in tension. The top is being squeezed or contracted and is in compression. Therefore, what we have when we analyze bending is a combination of the two axial stresses: tension and compression.

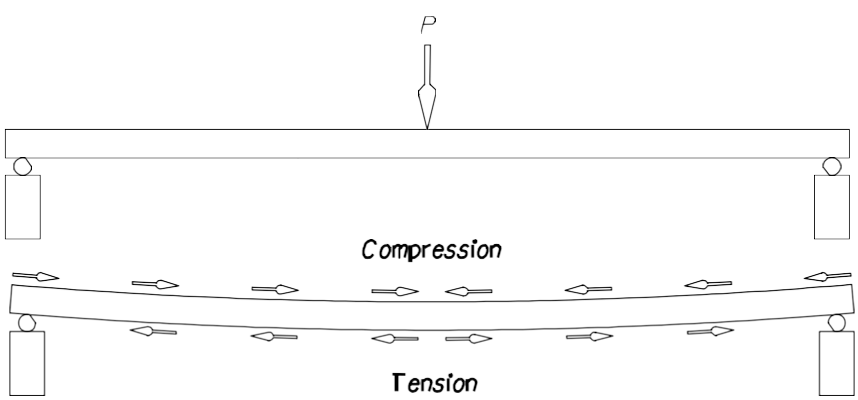


Figure 5.4-2 A simple beam supporting weight “P” at midspan causing the beam to deflect downward.

In order for the beam to be in equilibrium, the sum of all forces must equal zero; therefore, the sum of the forces at the end bearings (reactions) must equal the load “P”. In this example, we will neglect the weight of the beam itself.

Since the load is applied directly at the center of the span, the reactions will act equally in resisting it. Therefore, each reaction (R) must equal P/2.

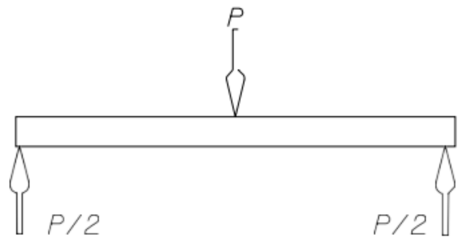


Figure 5.4-3 Free body diagram of beam.

As stated, the beam under consideration is in equilibrium. This being the case, any portion of the beam must also be in equilibrium. We, therefore, can draw a free body diagram of any part of the beam we choose.

Take a segment of the beam a distance "x" from the right reaction.

Figure 5.4-4 A segment of the beam a distance "x" from the right reaction.

As stated earlier, the reaction is equal to P/2. Because we know that this portion is in equilibrium, there must be a force just to the left of the cut equal in magnitude and opposite in direction to the reaction, P/2. This is called the shear force at this section and is designated "V".

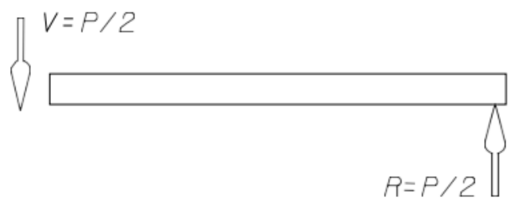


Figure 5.4-5 Example of shear force on a beam.

The sum of the vertical forces now equal zero; however, they have formed a couple which tends to rotate the member counterclockwise. For the segment to remain in equilibrium, this tendency must be resisted. This is done by an internal moment designated "M". The final free body diagram of the segment is shown below.

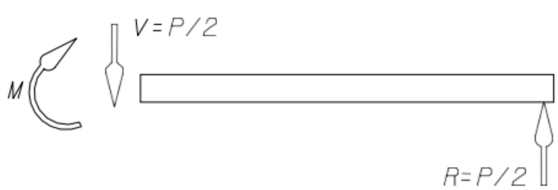


Figure 5.4-6 Free body diagram of the segment discussed above.

Laminations and Lamellar Tearing

Laminations, which generally occur during fabrication, are extensive and continuous imperfections lying parallel to the plate surface. Generally, they are aligned with the direction of principal stress and are seldom critical. However, they have been known to cause structural failures.

A lamination can result in an imperfection, which might lead to a stress concentration transverse to the applied stress and become critical. This is why all tension and stress reversal regions of a nonredundant steel tension member must be looked at, not just the fatigue-prone details.

Like laminations, lamellar tearing is a separation in the through-thickness direction of a plate.

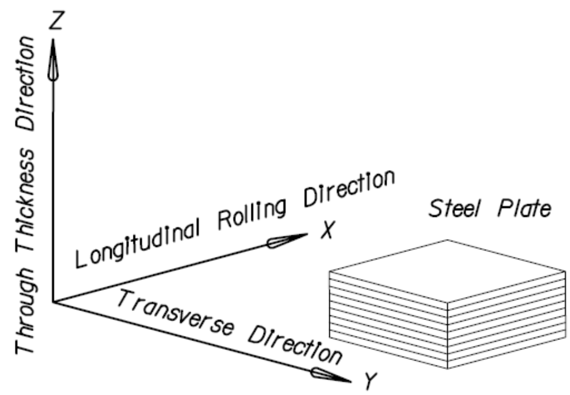


Figure 5.4-7 Lamellar Tearing and Lamination.

While lamination occurs during the fabrication or rolling process, lamellar tearing is the result of welding attachments to the plate. It is caused by weld metal shrinkage in highly restrained joints. A weld connecting a transverse stiffener to a girder web is an example of such a location. As the weld metal cools, it will contract and try to pull the web with it. If the web is highly restrained such, as near the flange, it will not be able to flex. Large stresses will result, and the web may separate along imperfections between the grains.

Beams

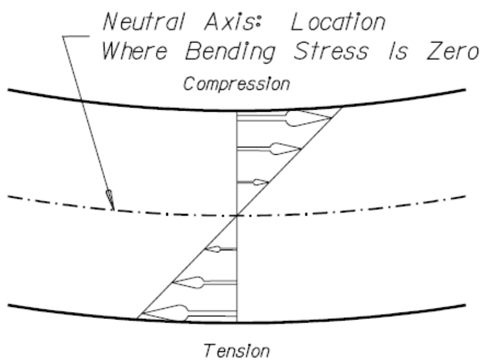
We have now established the stresses that occur in a beam.

Shear Stresses

Vertical forces that tend to displace vertically one part of a member relative to the adjacent part cause shear stresses. (Though this vertical displacement is impossible in real life, analysis and experimentation have shown the physical evidence of shear is cracks that appear at approximately a 45-degree angle with the horizontal.)

Bending Stresses

Tension and compression stresses, which vary linearly along the vertical face of the section. (When permanent deformation takes place, at the onset of yielding--refer to yield point in the glossary--this linear behavior no longer applies.)



Stress Distribution Varies Linearly From Maximum Compression at the Top to Maximum Tension at the Bottom

Figure 5.4-8 Bending Stress Distribution.

For the purposes of a nonredundant steel tension member inspection, we will consider the neutral axis to be located halfway between the top and bottom flange. This is not necessarily the case, but will be close enough for our purposes.

Until now we have dealt with a simply supported beam. The moment has caused the portion of the beam below the neutral axis to be in tension. We refer to this situation as positive bending, or a positive moment region.

Now consider a continuously supported beam. As was the case for the simple beam, it will deflect downward near midspan. However, as the beam approaches a support, the amount of deflection will decrease until at the support it becomes zero. The situation here is reversed from the simple beam. Relative to the adjacent spans, the portion over the support is deflecting upward; hence, the top of the beam is in tension. We refer to this as negative bending, or a negative moment region.

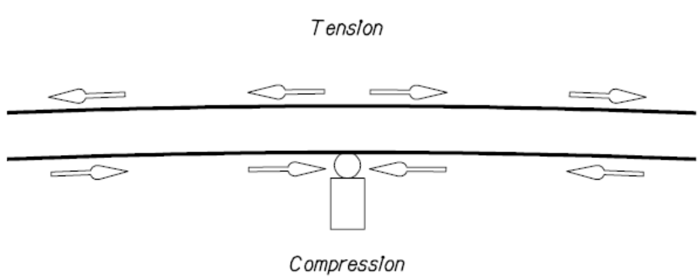


Figure 5.4-9 Negative Movement.

As the moment goes from negative at the support to positive at midspan, there must be some point between the two where the moment is zero. This point is called the inflection point, or the point of contra flexure. Because the live load moments at each section are constantly changing as a truck travels across the bridge, the inflection point is determined using only dead load moments.

An example of a graph, called a moment diagram, of the dead load moments at each section along the length of a three-span continuous beam.

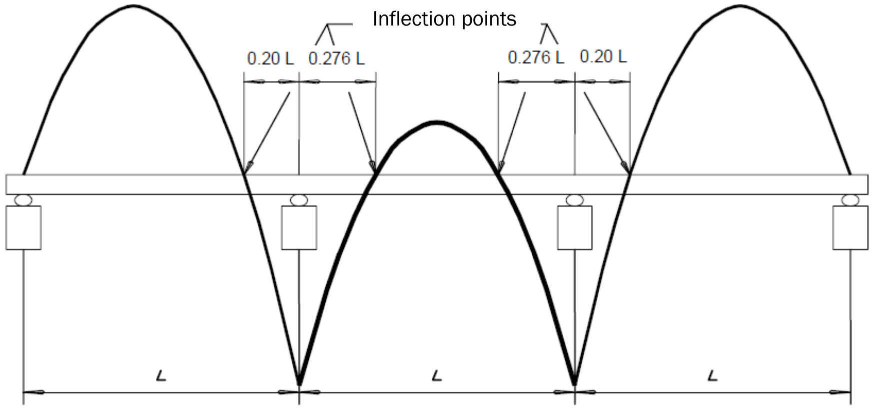


Figure 5.4-10 Moment Diagram – Dead Load

The dead load moments in the region of the inflection point are relatively small and can be overcome by a large live load as it moves across the bridge. In this area, a negative dead load moment may be changed to a net positive moment by the addition of the live load moment. A positive dead load moment may also be changed to negative. The overall effect is that a portion of the beam goes from being in a tension zone to compression and back again.

This portion of the beam is said to be in stress reversal for obvious reasons. This cyclic occurrence leads to fatigue in the member. It can cause cracking and eventual failure even though the stresses involved may never approach the yield point. Fatigue can also be a problem in areas that have stress ranges which are always in tension, but where the stress range and number of cycles is significant.

When inspecting beams, there are some important things to consider. In all instances, while inspecting steel I-beams, the flanges will carry the bending stresses as tension or compression. One flange will, therefore, be designated the tension flange, and the other the compression flange.

Almost exclusively the web will carry the shear stresses. In NSTM inspections, shear stresses are not our primary concern. However, if a crack does develop in the web, its ability to carry shear stresses will be reduced, possibly increasing the serious nature of the situation. This is especially important in the top (tension) portion of the web over or near the support, where shear stresses are high.

Trusses

A truss may be thought of as a special I-beam with most of its web cut away. The functions of the flanges in the beam are the same as the function of the top and bottom chord in a truss. The function of the I-beam's web is the same as that of the diagonals and verticals.

A truss is designed such that the overall bending stresses are carried as axial forces in individual members: the top and bottom chords. Likewise, the shear stresses are carried as axial forces in the diagonals and verticals.

Let's carry the correlation one step further. In the case of a beam, given a specific load and span length, we can decrease the bending stresses in the flanges by increasing the depth of the beam. In the same way, by increasing the depth of a truss, we can reduce the forces in the top and bottom chords.

A very small percentage, around four percent of truss bridges in Montana are continuous; therefore, in this manual we will concentrate on simple span trusses. Continuous trusses will be singled out and analyzed individually.

As was the case for the flanges in a simple beam, the top chord in a simply supported truss will be a compression member and the bottom chord a tension member. The distribution of shear forces is another matter. How each member of a truss panel will carry the forces in that panel depends upon the geometry of the truss. The following are some rules of thumb, which will help in determining how the diagonals and verticals react to loads applied to the truss.

Two exactly opposing structure types can help in this discussion: an arch and a suspended cable. In an arch bridge, the arch itself is always in compression. On the other hand, a suspended cable is always in tension. Using these two concepts will allow us to determine which diagonals are in compression and which are in tension.

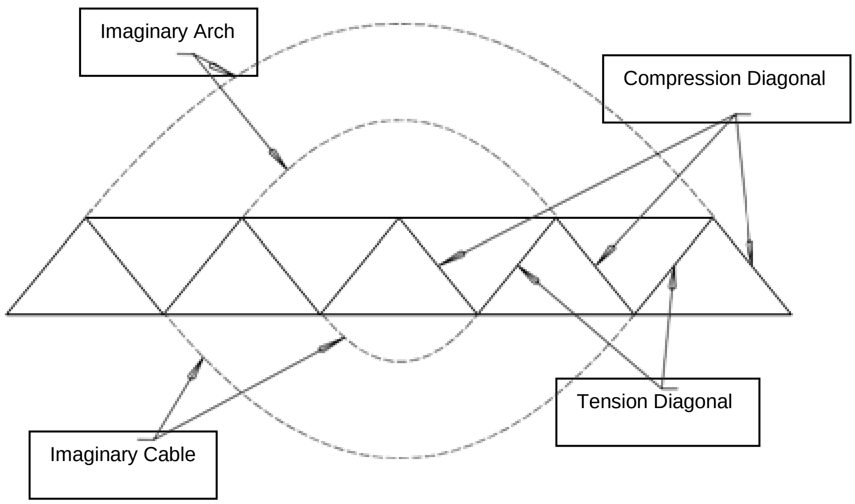


Figure 5.4-11 Diagonal Stress

After the stress in each diagonal is determined, stress in the verticals can be determined.

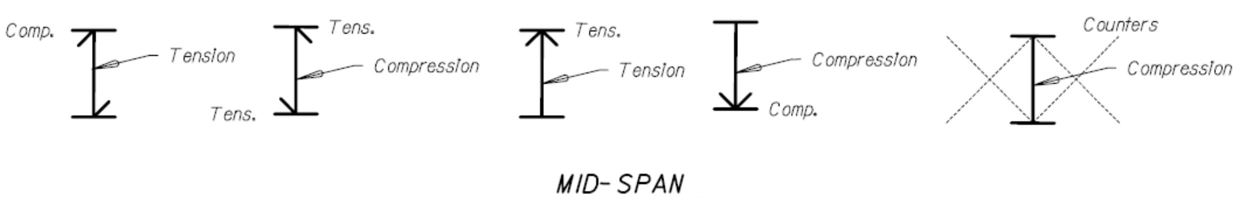


Figure 5.4-12 Vertical Stress

1. Those diagonals, which incline upward toward the center of the span, may be thought of as the ends of an arch and are, therefore, compression members.
2. Those diagonals, which incline downward toward the center of the span, may be thought of as the ends of a suspended cable and are, therefore, in tension.

Because tension members are the focal point of a nonredundant steel tension member inspection program, the bottom chord of a simple span truss must be checked thoroughly. Any diagonals and verticals, which were also determined to be tension members, must be examined as well. Also, any connection or splice plates on NSTMs require an NSTM inspection.

5.4.3 Redundancy

Structures have properties that can compensate for failure. Failure from stress or fatigue can be compensated by the structure redistributing the load via load paths to alternate locations.

Redundancy is the ability of other members to help carry the load, providing duplication of replacement of some function, when a member becomes weak or fails. Where bridges are concerned, the term redundancy can be divided into three distinct areas: load path, structural, and internal.

Load Path Redundancy

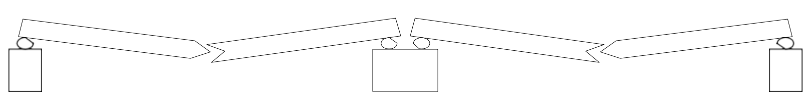
Load path redundancy considers the number of supporting members (e.g., stringers) that transfer the deck loads to the substructure. Each supporting member would be considered a separate load path.

An easy way to picture this is to look at the number of bearings at each bent or pier. The deck loads are delivered through the supporting members to the substructure at these locations. The number of bearings a bridge has at each bent can determine the number of load paths a structure has.

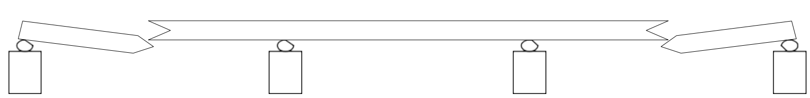
A structure is considered non-redundant if it has two or less load paths. A truss bridge, using only two trusses, has two bearings at each pier. Having only two load paths, it must be considered non-redundant. Conversely, multi-girder bridges with three or more girders and, therefore, three or more load paths, are redundant.

Structural Redundancy

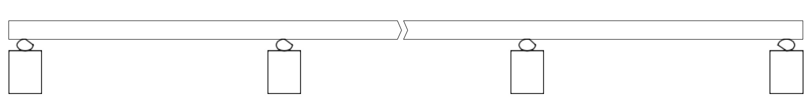
Structural redundancy refers to the number of substructure units and the way in which those units are used to support the superstructure. To be considered structurally redundant, a bridge must have a minimum of three continuous spans, and then all spans except for the end spans are redundant. A structure constructed of a simple span or a series of simple spans is considered structurally non-redundant.



Structurally Non-Redundant (Two Simple Spans)



Spans 1 and 3 – Structurally Non-Redundant (Three Span Continuous)



Span 2 – Structurally Redundant (Three Span Continuous)

Figure 5.4-13 Examples of structural redundancy.

Internal Redundancy

Internal redundancy relates to a particular structural member and the redundancy created by the independence of its individual components. A good example of an internally redundant bridge member is a riveted plate girder. This type of girder is constructed of double angles (which provide the flanges) riveted to a web plate. A crack beginning in one leg of one of the angles may eventually separate the entire angle, but it is not likely to travel into the web plate.

On the other hand, a welded plate girder cannot be considered internally redundant. The weld fuses the different components together, so they become a single section. Cracks appearing in one portion may propagate into adjacent elements through the weld itself. In fact, far from hindering crack propagation, flaws in the weld in many instances are the cause of cracking found in welded plate girders.

Some examples of internally redundant and non-redundant members are given below.

Internally Redundant	**Internally Nonredundant**
Riveted or bolted plate girder	Welded plate girder
Cables constructed of several strands	Single strand cables
Multiple eyebars in a truss member	Single eyebar in a truss member

If a crack or flaw develops in a structural member, the only stresses that will cause it to propagate are tension stresses. For the ends of a crack to spread, the faces of the crack must be pulled apart. This can only occur in a tension zone and only when the crack is at an angle or across the direction of the applied tensile stress. Therefore, when inspecting NSTMs, the compression areas of those members may be neglected.

5.5 Steel Bridge Inspection

There are five main types of Nonredundant Steel Tension members/systems in Montana:

- Trusses
- Two-girder systems
- Bridges using transverse girders (including all floor beams)
- Pin & Hanger assemblies
- Steel Pier/Bent Caps

Note that MDT has a separate contract to ultrasonically test the pins in pin & hanger type bridges. The scope and terms of those inspections are specified in those specialty contracts.

5.5.1 Hands-on Inspection of Steel Girders (Reserved)

Reserved

5.5.2 Truss Bridges

Only the tension members of a truss are singled out for NSTM inspection; however, Montana requires all truss members to be inspected hands-on, per Appendix 9A. As is the case with any axial tension member, the critical locations are the connections at either end. While the entire member must be looked at, the inspector will be especially careful at the ends.

There are two types of trusses used in this state: riveted and pinned.

- Riveted/Bolted Truss - A truss constructed of structural sections riveted or bolted together using plates or lacing to connect the sections. Gusset plates and rivets/bolts are usually used at all connections.
- Pinned Truss - Compression members are built-up members similar to those of a riveted truss. Tension members are eyebars or rods. Pins are used at the connections.

Riveted/Bolted Trusses

As connection points for these mechanically fastened trusses, gusset plates will be checked closely as they are considered an NSTM. Fastener holes are locations of stress concentration in the gusset plate. The critical portions of the gusset plate are the exterior lines of fasteners at right angles to the applied stress (perpendicular to the centroidal axis of the member). The reason for this is that cracks will propagate at right angles to the tensile stress. The entire set of gusset plates at each connection point will be evaluated. If geometry of the connection precludes a full visual inspection and the inspector can find no problems in these critical areas, he/she can be fairly confident of the rest of the connection.

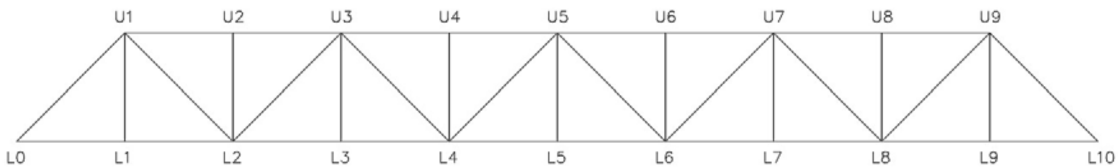
Pinned Trusses

Again, as was the case for the riveted/bolted truss, the connections are crucial. In pinned trusses, the members either have pin holes or are looped at the ends and held together with pins - see Parker Truss Connection Detail below.

The method used to form the ends of eyebars on these old bridges is called forge welding. It involved heating the metal to a plastic state and hammering it into shape. On the lighter bridges, one piece of steel (generally a circular rod) was used. The bar was heated, bent around a pin, and formed back on itself. On larger bridges, the ends of the eyebars (generally rectangular bars) were cast in a mold separately and then forge welded to the bar itself. A thorough visual inspection will be considered adequate at these locations.

NDT testing will very likely detect some sort of flaw at all connections using forge welding. Therefore, unless the flaw can be seen, it will not be considered critical.

Warren Truss



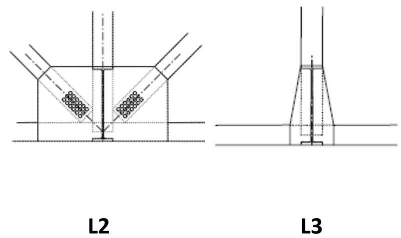


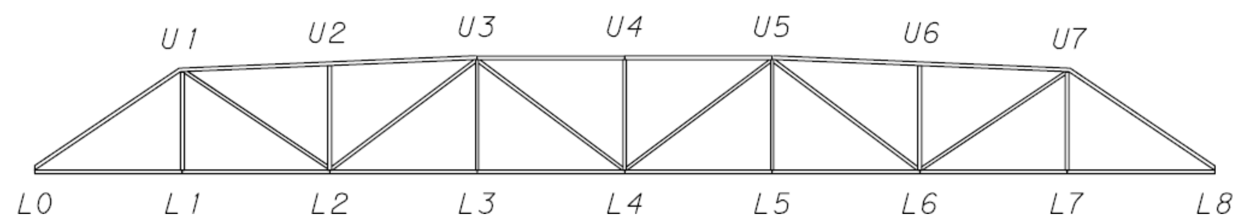
Figure 5.5-1 An example of a warren truss bridge section with connection details.

The diagonals in a warren truss will carry both compressive and tensile forces. Verticals that frame into the bottom chord by themselves (no diagonals frame into the bottom gusset plates) are tension members (see L3 above). The verticals which frame into the top chord by themselves serve only as bracing for the top chord and, therefore, may be considered compression members only.

The first line of rivets (or bolts) transverse to the applied stress and closest to the center of each member are the most critical; however, all rivets (bolts) will be inspected closely, where accessible.

- Diagonals U1-L2, U3-L4, L6-U7, and L8-U9 are tension members for this particular truss. These members and their connections along with the bottom chord and the tension verticals will require NSTM inspection.

Camelback (Warren) Truss



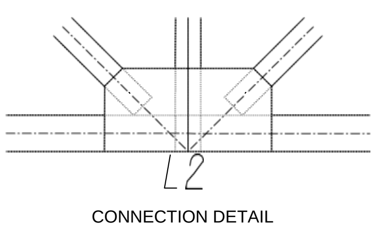


Figure 5.5-2 Additional image of a camelback (warren) truss bridge.

Sometimes referred to as a camelback because of its top chord having exactly five slopes, the truss pictured is actually a Warren.

The inspection requirements for the Warren truss will apply here, too. The tension diagonals are U1-L2, U3- L4, L4-U5, and L6-U7. These, the bottom chord, and the gusset connections and the tension verticals will require the Nonredundant Steel Tension Member.

Parker Truss

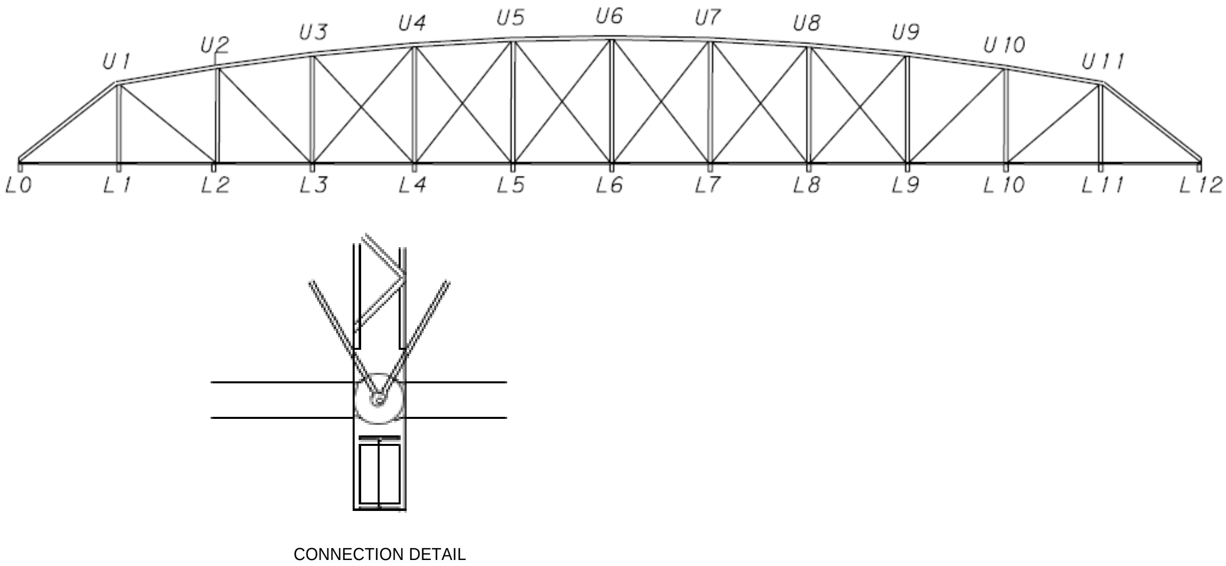


Figure 5.5-3 An example of a Parker truss bridge.

The verticals in this truss are all compression members. The diagonals are all tension members. This is one case in which the arch and suspender analogy will not apply because here we are dealing with counters. The diagonals in the middle six panels are all counters and, as such, are unable to accept any significant compressive load. The shear loads in each of these six panels are carried by one of the counters as a tensile load. When a truck crosses the bridge, one counter will carry the entire load until it begins to go into compression, at which point it becomes ineffective and the other counter takes over.

The connections in this truss are pinned. The bars, which are used as tension members have been forge welded. The lighter counters consist of a rod which has been bent around a pin and bent back on itself. The larger counters and the lower chord are bars whose ends have been cast separately. These have then been forge welded onto the bar itself. All of these connections must be visually inspected very thoroughly.

Pennsylvania Truss (Subdivided Parker)

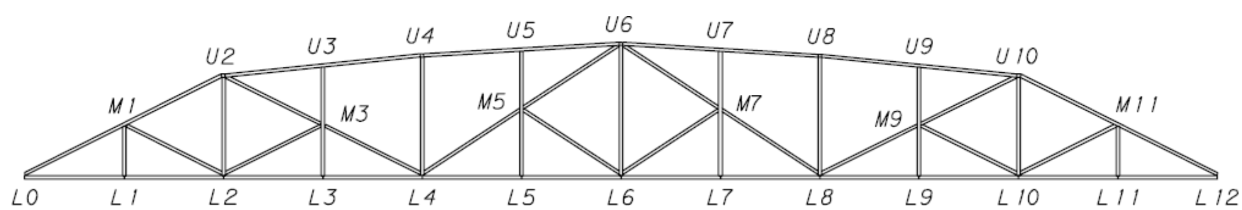


Figure 5.5-4 A Pennsylvania truss bridge.

Sometimes for large span bridges, a truss will be subdivided to reduce member sizes and to shorten the span length between floor beams. The newly added members are referred to as sub-diagonals and sub-verticals. They may also be referred to as sub-struts (if they are compression members) or sub-ties (if they are tension members).

The main interior diagonals for the truss pictures will behave as given in the rules of thumb. That is, U2-L4 and L8-U10 are tension members. L4-U6 and U6-L8 are compression members. After determining the diagonal stresses, the vertical members will obey the tension and compression rules. The sub-verticals M1-L1, M3-L3, M5-L5, etc., will be tension members because they frame into the lower chord without the presence of diagonals. The sub-verticals U3-M3, U5-M5, U7-M7, and U9-M9 are braces for the top chord and are considered compression members. The main verticals U2-L2, U4-L4, U6-L6, etc., are compression members.

The only members of this truss where the rules of thumb do not apply are the sub-diagonals. They are all compression members no matter what direction they are inclined. Their main function is to prevent the main diagonals from being bent laterally due to the tensile loads being applied by the sub-verticals.

This truss may look complicated, but it really is not. The members requiring an NSTM inspection are the lower sub-verticals; the main diagonals inclined downward, U2-L4 and L8- U10, and the bottom chord.

5.5.3 Two-Girder Systems

The NSTM members on a two-girder system are the two main girders. The NSTM critical components are those parts of the girder within tension zones or areas of stress reversal, if it's continuous.

The inspection of two-girder systems will generally follow the guidelines set forth in the article on beams. The inspector will need to determine the tension and stress reversal zones before beginning the inspection. In tension zones, only that half of the girder in tension needs the full NSTM inspection. In areas of stress reversal, the full depth of the girder must be given this type of inspection.

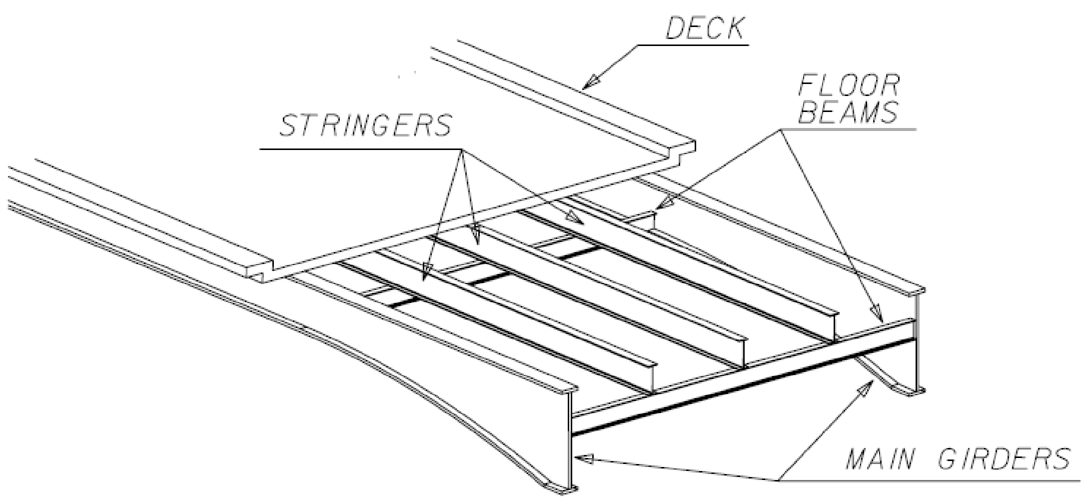


Figure 5.5-5 Cross-section of a two-girder system.

Locating Zones of Stress Reversal in Continuous Girders

In those cases where longitudinal stiffeners have been used, their placement near both the top and bottom flanges is an area of stress reversal as shown in the below diagram.

Without the presence of longitudinal stiffeners, inflection points are located between 20% and 30% of the span length from either side of each intermediate bent. In most cases, a field splice has been placed at these locations. In these instances, the zones of stress reversal will be taken as the area equal to 0.15 times the span length on both sides of these splices.

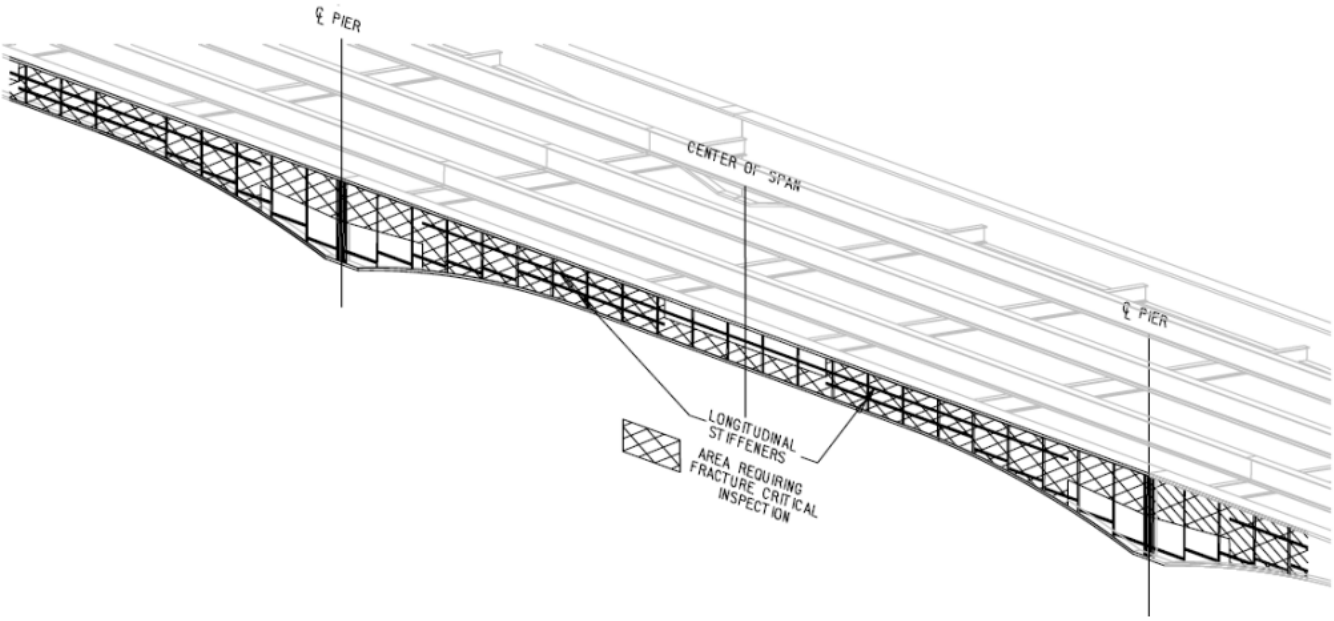


Figure 5.5-6 Main Girder Inspection with Longitudinal Stiffeners.

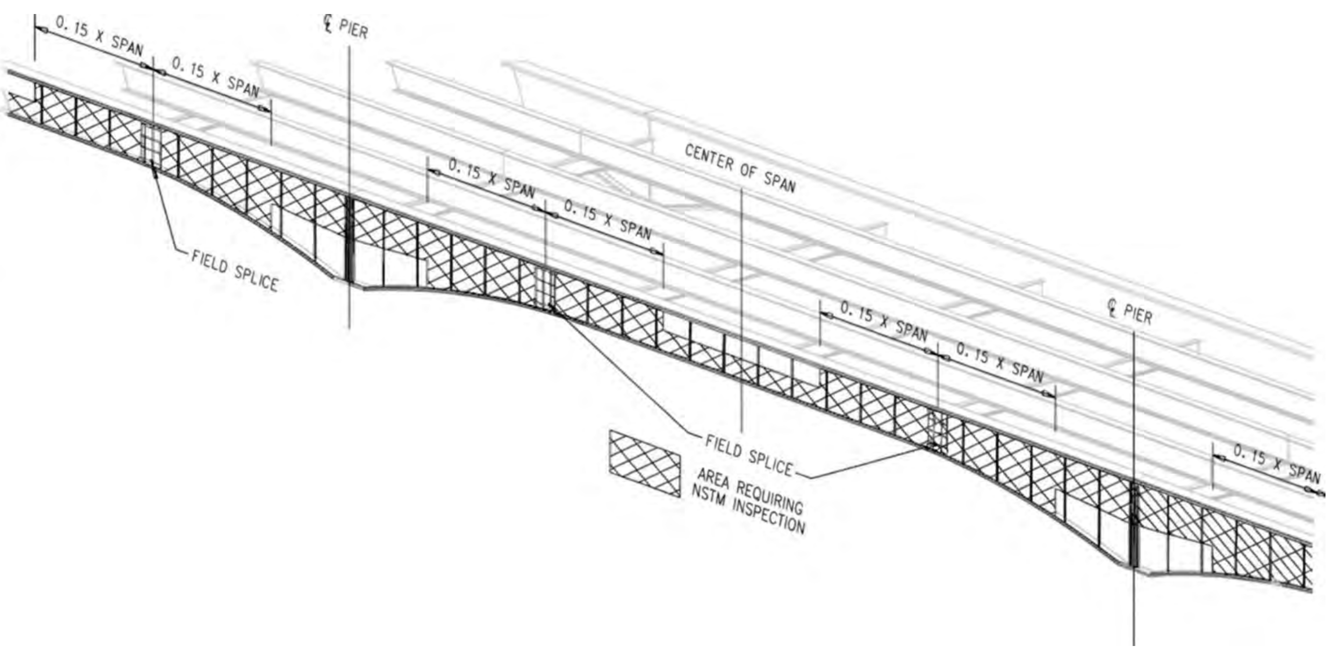


Figure 5.5-7 Main Girder Inspection with Field Splices.

If field splices or longitudinal stiffeners have not been used, the inspector will perform a full-depth inspection at each intermediate to a point 0.50 times the span length from the bent. This will be done on both sides of the bent.

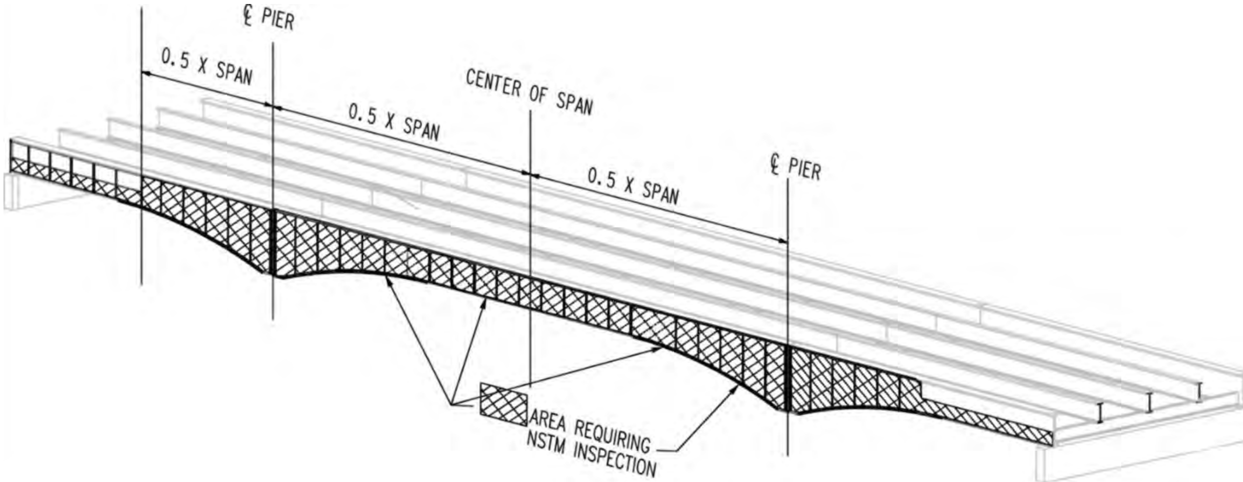


Figure 5.5-8 Main Girder Inspection without Field Splices or Longitudinal Stiffeners.

Gusset Plates

Gusset plates are used in many instances to attach lateral bracing to the web of the girder. Unlike the case with riveted trusses, the plates themselves are not considered NSTMs. However, the lateral bracing will vibrate as a vehicle crosses the bridge. This vibration can cause cracking in the girder's web at the gusset plate attachment. If this happens to be in a tension zone, the tensile stresses may cause the crack to propagate.

Transverse Stiffeners

In the case of a welded plate girder, any weld perpendicular to the direction of applied stress is critical and must be inspected thoroughly. The reason is that any flaw in this kind of weld is a point of stress concentration transverse to the direction of the principal stress.

The weld attaching a transverse stiffener, by definition, qualifies as a category "C" fatigue detail. However, this weld is more critical when welded to a tension flange.

In riveted girders, the same rules apply as those used for gusset plates in riveted trusses. Rivet holes are points of stress concentration. The line of rivets is at a right angle to the direction of principal stress and are considered fatigue category "D".

Longitudinal Stiffener

Longitudinal stiffeners are critical only when used on a welded girder. Their function is to reinforce the web in the area of the compression flange and, as such, they are not significant unless used in a zone of stress reversal as mentioned above.

Because the welds connecting longitudinal stiffeners are parallel to the direction of principal stress, they are not in and of themselves critical. However, discontinuities or flaws in the weld may cause stress concentrations that can be perpendicular to the applied stress. Such a flaw may propagate under cyclic loading.

Floor Beam to Girder Connection Near an Interior Support

Whether inspecting a welded plate girder or riveted girder, these locations need special attention. In these regions, the movement of both flanges, the top flange by the slab and the bottom by the bearing of the main girder, is restricted. As a truck deflects the floor beam, its bottom flange is pushed toward the girder while the top flange is pulled away. This prying action causes out-of-plane bending in the girder web. Because the flanges of the girder are restrained, the bending in the web results in stresses which will exceed the yield point.

Repeated loading can, in time, cause cracking in the web of the girder. Because this occurs near support, the tension zone is the upper half of the girder. It is this portion of the web that must be checked out thoroughly.

Welded Cover Plates

An abrupt change in the flange cross section is a stress riser which will cause a stress concentration in the fillet weld at the end of a cover plate. Whether or not the weld is brought around the end of a cover plate is of little consequence. The end of a cover plate has a low fatigue strength and is susceptible to cracking with or without a transverse end weld. The problem occurs mainly when the end of the cover plate is left in a region of positive moment (tension in the bottom flange).

5.5.4 Pin and Hanger

In June 1983, a failed hanger pin initiated the collapse of one span on the Mianus River Bridge on the Connecticut Turnpike. The incident resulted in the deaths of three motorists. Following the collapse, there was an immediate increase in interest in the inspection and condition assessment of bridge hanger pins.

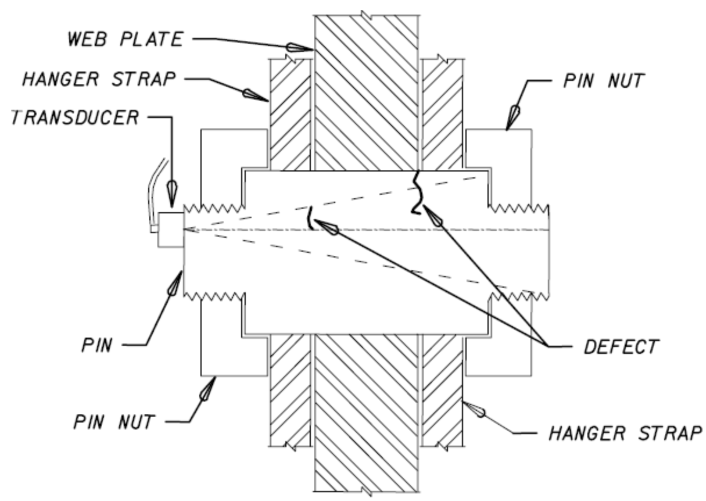


Figure 5.5-9 Pin and Hanger Assembly

Hanger pins are structural elements connecting the suspended span of a bridge to the fixed cantilever arm of the same bridge, a diagram of a pin and hanger assembly is shown in the figure above. The primary function of a pin and hanger connection is to allow for longitudinal thermal expansion and contraction in the bridge superstructure. These connections are designed to support the transfer of shear forces from the suspended span into the anchor span. As long as the connection is operating properly, neither shear forces from the anchor span nor moments from either span can be transmitted across the connection. In general, loads from the suspended span are transmitted into the anchor span as follows: The loads travel from the suspended girder web reinforcement plate to the lower hanger pin and into the hanger plates (labeled strap in the diagram). From the hanger plates, the load is then transferred into the upper hanger pin and finally into the anchor girder web reinforcement plate. This load path creates two shear planes in each pin – one at each of the intersections of the web reinforcement plate and hanger plate. If a pin were to fail along both shear planes, the portion of the bridge section suspended by that pin would be unsupported.

Pin and hanger connections are typically located directly beneath bridge expansion joints. Consequently, they are frequently exposed to water, deicer and debris that fall through failed joints. The presence of moisture in the confined interfaces between the hanger plates, web and around the pins can lead to pack rust and corrosion of both of these elements and of the pin, at the critical shear planes. This corrosion can have two detrimental effects on the pin. First, the cross-section of the pin can decrease due to corrosive section loss. This corrosion produces pitting that may act as a crack-initiating site. Second, corrosion can effectively lock the pin within the connection so that no rotation about the pin occurs. This can lead to large torsional stresses, within a reduced section in the pin. The torsional stresses, combined with the shear stresses, provide a likely location for the development and propagation of cracks and the eventual failure of the connection. Therefore, the most likely location for a crack to be initiated is at the hanger to the web interface. This area of interest is closely examined using the Ultrasonic method.

- Pin and hangers are not Nonredundant Steel Tension Members unless they are used in conjunction with an already Nonredundant Steel Tension Member (e.g., main girder in a two-girder system or a truss). However, they are often used in multi-beam bridges. There have been instances where the failure of one assembly has led to a domino-effect failure of successive assemblies. For this reason, in Montana, they have been given a high priority for a Nonredundant Steel Tension Member type inspection whether used in an NSTM bridge or not. All bridges using pin and hangers will be included in this program.

A pin and hanger assembly is used to suspend a span from a cantilevered arm. The main reason for using this type of design is that it allows for economy in selecting structural members. It also lets us move the expansion joint out away from the bent. This keeps the joint from leaking on an abutment or pier. The problem is that, if the joint was going to leak on the abutment or pier, it would now leak on a pin and hanger assembly.

The thermal expansion and contraction that takes place in this type of bridge is accounted for in these assemblies. The hanger rotating around the pins allows for this movement. Water, and especially water in the presence of salt, will set up a corrosive action between the pin and hangers. This corrosion can build up until the hangers' ability to rotate becomes completely frozen. The inability for these details to move as the bridge expands or contracts will cause stresses in both the pin and hangers. Stresses could perpetuate cracking and eventual failure.

Corrosion is important, but the bearing of stresses that these details experience can also cause problems that, in most instances, will be hidden from view. For this reason, the pin and hanger assembly should be inspected using ultrasound during a Pin and Hanger Inspection.

Visual inspection is used only as a method to gather obvious information. On pin and hanger assemblies, due to access limitations, visual inspections will not detect a defect that is not open to the surface or is covered with paint, rust or organics. The pins primary area of interest is the body of the pin, and is inaccessible due to the hanger assembly configuration. Another inspection option is to measure the position and certain gaps and offsets between various pin and hanger components and note any unusual or inconsistent measurements. They can also be compared from cycle to cycle. See Section 5.7.2 for measurement forms that can be used for suspect pin and hangers.

Ultrasonic inspection is one of the most reliable methods used to inspect pins, and has become the primary method of performing a detailed inspection of an in-service hanger pin. Ultrasonic Testing offers a reliable method by which pins may be inspected in the field without the removal of the pin being required. The portability of the equipment, reliability, and cost to complete an inspection makes Ultrasonic Testing the logical method for inspection. One exception to this would be that some pin and hanger assemblies have pin caps held in place via a through bolt which also restrains the pin from shifting and the hanger plates from spreading. The pin cap covers the end of the pin, so that neither visual nor ultrasonic inspection of the pin end can occur, unless the cap is removed. This will only be done after a separate temporary restraining clamp or system is in place to prevent the hangers from spreading and falling off the pins.

Ultrasonic standards are fabricated using precise tolerances with induced defects of a known dimension. Calibrations are performed to ascertain reliability and sensitivity of the system used to inspect the pin.

5.5.4.1Pin and Hanger Inspection

Visual Inspection Procedures

Visually inspect Pin & Hanger assembly for the following:

- Loose or missing nuts
- Pack-rust behind the hanger
- Proper movement of the hanger
- Deformations of the hanger assembly
- Cracks
- Nicks or gouges

Ultrasonic Inspection Procedures

Note that ultrasonic testing of pin and hanger assemblies is performed through a separate contract with its own special scope requirements.

5.5.5 Other Inspection Procedures (Reserved)

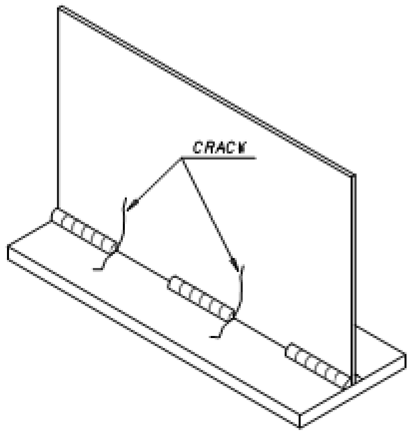
Reserved

5.5.6 Common Fatigue-Prone Details Along Steel Bridge Elements

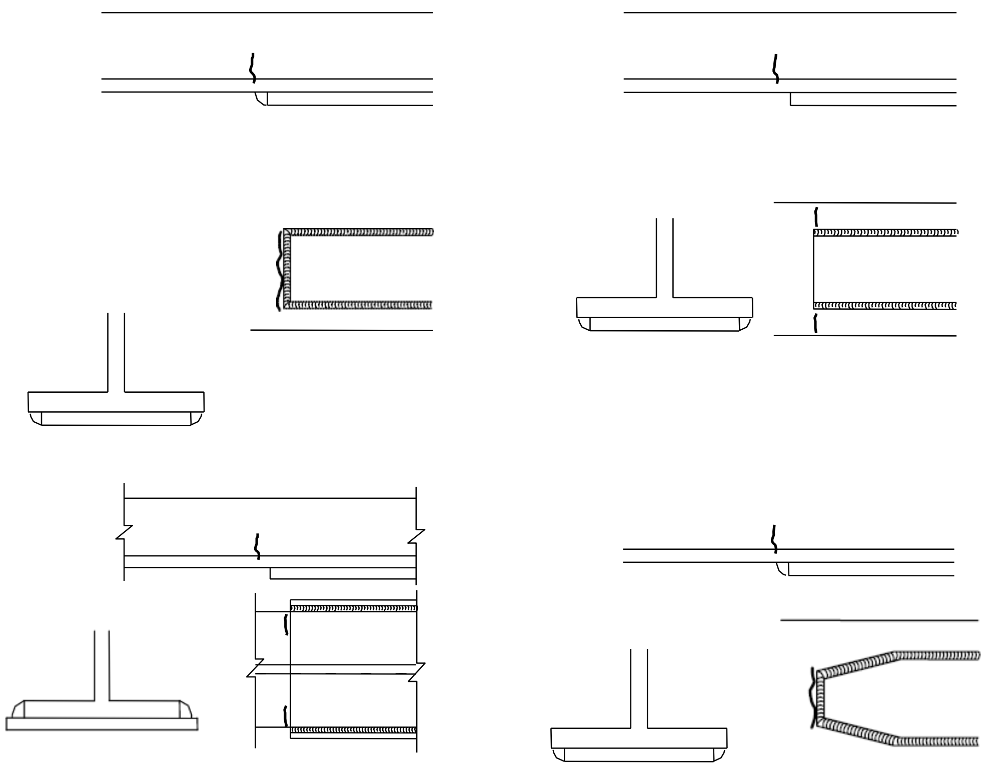
During the inspection of the structure, the inspector will be concerned with details and problem areas that influence the health and strength of the bridge. Some of these details and areas are summarized below.

Examples of Details That Will be Checked Closely Are:

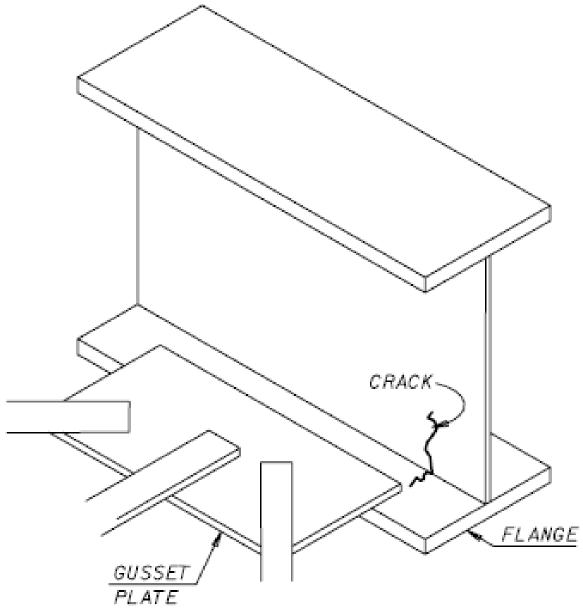
1. Intermittent welds between the web and tension flange.



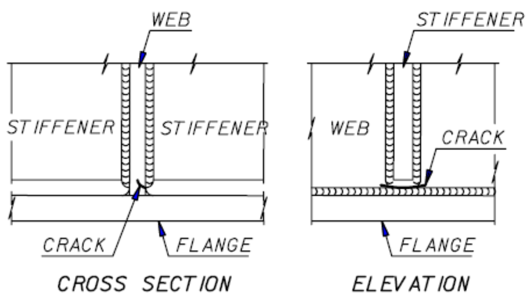
2. Areas of sudden change of cross-section. Examples, near the ends of cover plates.



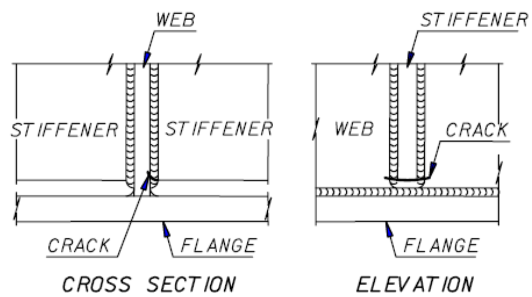
3. Location of stress risers such as nicks, scars, flaws, and holes that have plug welds, irregular weld profile, and areas where the base metal has been undercut during welding.
4. Locations where stiff bracing members of horizontal connection plates are attached to thin webs and girder flanges.



5. Gusset plates, improperly coped members re-entering corners, and the gap between web stiffeners and flanges.

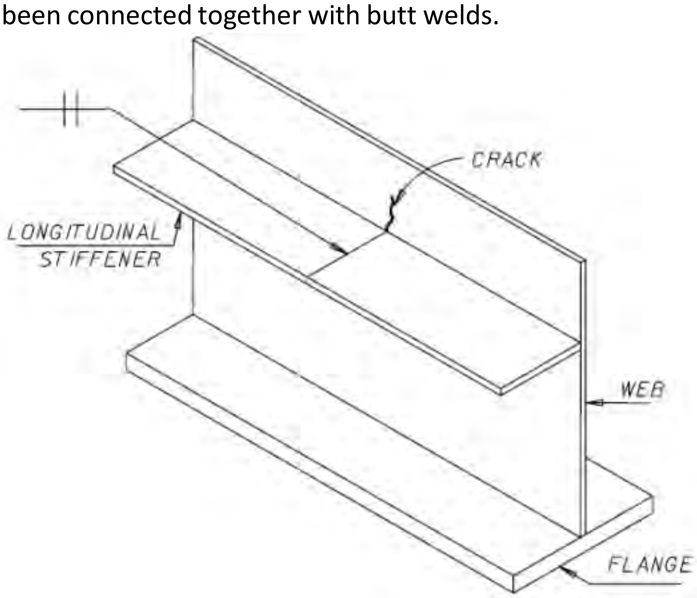


Schematic of crack at end of stiffener welds.

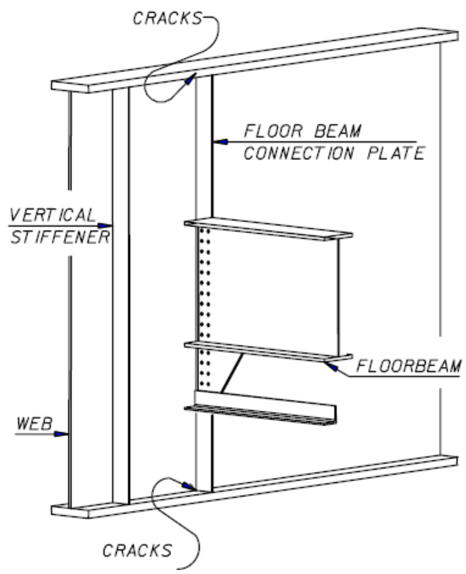


Schematic of crack at end of stiffener into weld (and web).

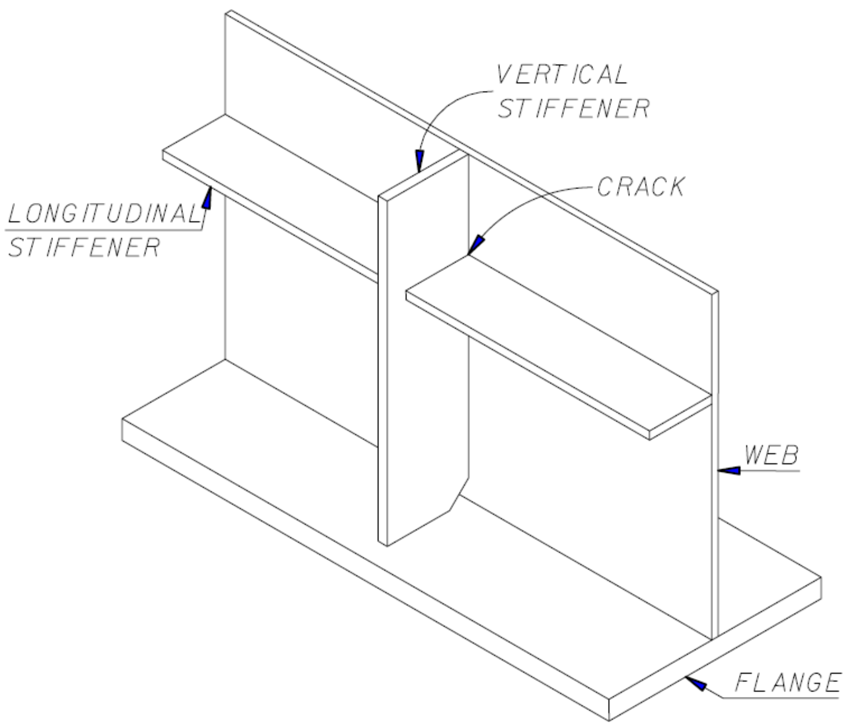
6. Stiffeners that have been connected together with butt welds.



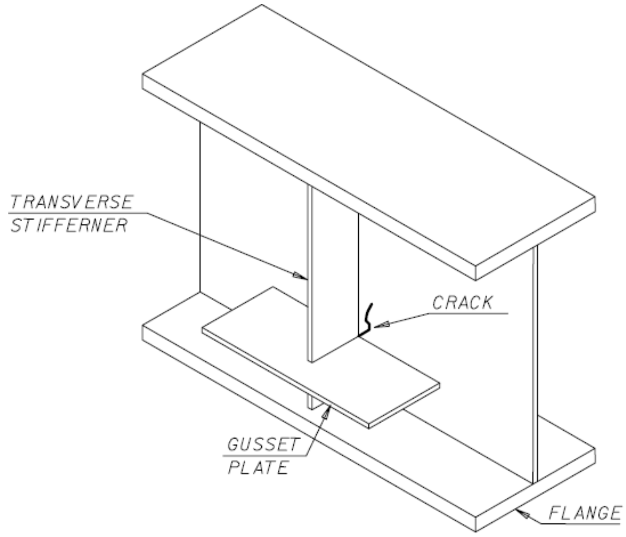
7. The web adjacent to a floor beam connection plate.



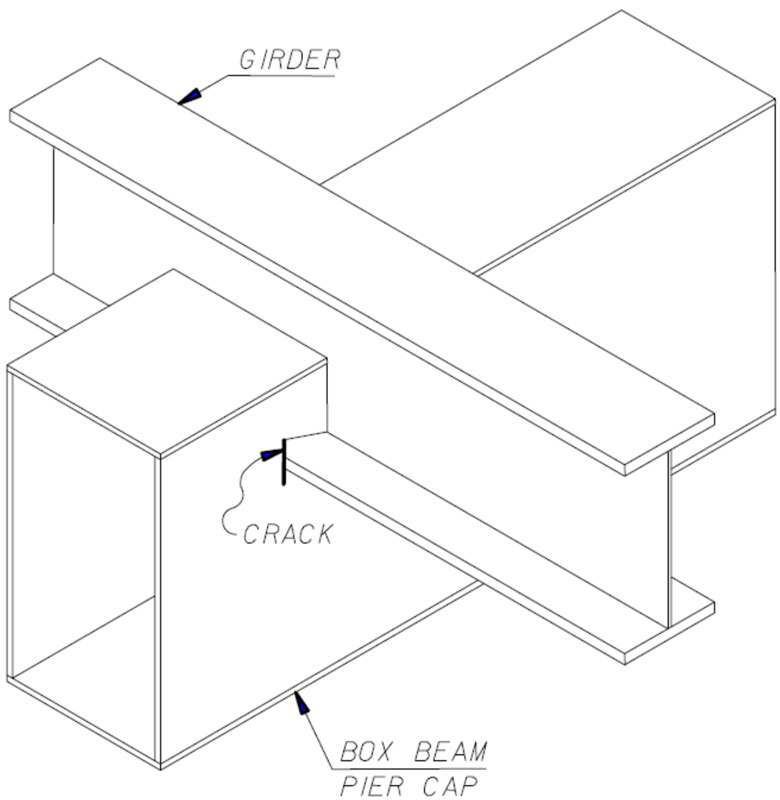
8. Longitudinal and vertical stiffener intersections and intersecting welds.



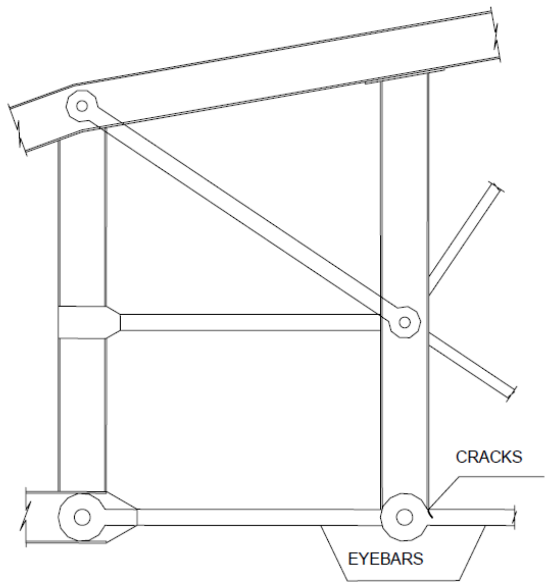
9. Location of welds at gusset plate-transverse stiffener-web or flange intersections.



10. Flanges that pass through a web, such as a girder flange passing through a box girder pier cap.



11. Eyebars.



Areas Where Corrosion is likely to cause problems are:

- Under deck joints.
- In the areas around scuppers and drainpipes.
- On flat surfaces where debris accumulates.
- At overlapping steel plates.
- At corners of steel angles and channels.

Other Special Details That Will be Given Attention During NSTM Inspection Are:

- Tack welds on bolted or riveted connections.
- Unfilled holes or holes filled with weld metal.
- Field welds in tension zones.
- Suspicious attachments made in tension zones, such as utility attachments.
- Fabricator stamps on girders.

5.6 Deck Inspection

5.6.1 Timber Decks

Most State-owned timber decks in Montana were constructed between the mid-1920s and early 1950s. They are nominal 2x4 nail-laminated construction (Douglas Fir/Larch) with the occasional plank widening and almost all have an asphalt overlay.

Non-State owned (usually County) timber decks consist of a variety of construction types (nail-lam, plank, glue-lam panels, etc.) and may be bare, covered in gravel or asphalt, or have timber or metal running planks.

References: BIRM Section 8.3
MDT Timber Bridge Inspection Guide

5.6.1.1 Inspection and Documentation Requirements

Initial/Inventory Inspections & Routine Inspections

Inspection

- Inspect the deck in accordance with BIRM Sections 8.3.5 and 8.3.6.
- Inspect the top and edges of deck visually observing the condition of the top surface or overlay. See Section 5.6.4 for inspection and documentation requirements for overlays. The entire top and edge surfaces will be inspected from a distance that is appropriate to identify and evaluate defects consistently and accurately for weather conditions, light conditions, defect type and severity.
- Inspect the entire underside of deck checking for signs of decay, weathering, and damage. Normally, observation of the decking during the course of the superstructure inspection will provide an adequate inspection distance.
- Sound with a hammer or probe with a pick, all exposed top surface, soffit, and sides of the timber decking, any discolored, damp, or water-stained areas, areas covered with moss or fungus growth, and other areas of suspected decay to determine the presence or extent of internal decay or voids. Be aware of frozen timber that may have internal deterioration but sounds solid due to water frozen in internal cavities.
- Examine the laminated surface on laminated timber decks for separation.
- Examine fasteners connecting the decking to the girders or support system for loosening.

Documentation

- Measurement forms for the deck and the superstructure will be completed during the initial inspection, any time the deck is replaced or any time the curb and/or rail is replaced or revised.
- Organize deck notes in a span-by-span manner and in such a fashion that it is possible to account for “overlapping” defects on both the top and bottom of deck, so that the roll-up condition state quantities will be correct.
- For the top surface and underside of timber decking, note the size and location of severe (CS-4) checks and shakes, splits, cracks, breaks and decay. Also note the location of loose attachments to the floor system and the cause of this condition (wood shrinkage, decay, crushing). Where these cannot be described narratively, provide a custom sketch showing the size and location of the defect.
- Document significant changes in condition state or discovery of critical findings and report in accordance with Section 9.3.3 and Section 5.2 of this manual.
    - Accurately specify the location of the defect on the deck by referencing the span, lane, relation to a bent, etc. Provide custom sketches as necessary to aid in locating defects.
    - Take typical photos of defects that are noted in the element descriptions.
    - Provide photos of decks on County owned timber structures to aid Load Rating Engineers in determining the grade of lumber.

Figure 5.6-1 Deterioration of timber plank deck surface.

Damage Inspections

Inspection

- Inspection methods will vary depending on the type and severity of damage. Timber deck elements that have been damaged by fire may require a widespread visual and physical examination including the removal of charred surfaces, sounding, and probing. Damage caused from vehicle live loads, such as a single cracked or broken timber deck plank, may require a visual examination at only one location.
- Coordinate the damage inspection between the inspector, bridge owner, and any other relevant agencies to determine the scope of damage and planned inspection methods.

Documentation

- Include thorough documentation of the condition of any deck element that has been damaged. Photographs of the damaged areas are required, and sketches are encouraged if text alone cannot easily convey the scope of the damage.
- As stated in Section 4.1.6 of this manual, information obtained during damage inspections are typically used in the decision-making process for implementing or lifting emergency load posting restrictions or bridge closures.

5.6.1.2 Report Review

- Review the inspection findings in accordance with established Quality Control and Quality Assurance procedures.
- Compare the present inspection to past inspection reports to determine if the pattern, quantity and severity of the defects found support the numerical condition rating given.

5.6.1.3 Maintenance Considerations

- Only perform minor maintenance that will facilitate better access and/or allow better visual evaluation of an element, such as:

- Removing any accumulations of sand or debris to allow visual or sounding evaluation of the deck.

- Limit Work Candidates/Repair Suggestions to items that can generally be performed by in-house MDT Maintenance forces, such as:
  - Repair rotten decking
  - Recommendation to clear drains

5.6.2 Concrete Decks

Concrete decks are the most common deck element on Montana bridges. Generally, the expected design life is at least 30 years. Documenting the defects and deterioration of concrete decks properly will ensure that any maintenance or rehabilitation work necessary can be scheduled and performed at the optimum time to extend the service life of the deck.

Reference: BIRM Section 8.1 and Appendix 6A "Transverse Cracks and Jump Cracks" Memorandum

5.6.2.1 Inspection and Documentation Requirements

Initial/Inventory Inspections & Routine Inspections

Inspection

- Inspect the deck in accordance with BIRM Sections 7.1.6, 7.1.9, and 8.1.5.
- Also inspect and document per Appendix 6A "Transverse Cracks and Jump Cracks". Jump cracks are deck cracks that run perpendicular to transverse cracking and can extend from one transverse crack to the next. A set of parallel jump cracks between two transverse cracks will form a rectangular "concrete island", which is prone to becoming loose.
- Walk the top of deck visually inspecting its condition. Observe the entire top of deck from a distance that is appropriate to identify and evaluate defects consistently and accurately for weather conditions, light conditions, defect type and severity. Normally this can be done safely from the shoulders without the need for traffic control operations. However, if the roadway is narrow or traffic speed or volume considerations make it unsafe to walk the deck without protection, coordinate and schedule lane closures with the bridge owner.
- View and inspect the underside of deck from a distance and with sufficient lighting to detect CS-2 level defects. Normally, observation of the deck during the course of the superstructure inspection will provide an adequate inspection distance.
- Sound with a hammer, areas of suspected delamination on the underside of the deck and at least 10% of those areas showing cracking, scaling, moisture, efflorescence, or staining to determine concrete soundness.
- For precast deck slabs, inspect the deck panel anchorages and connections in addition to the normal concrete deck inspection).
- On bridges with stay-in-place forms, follow the inspection procedures for concrete decks. Note any rusting visible on the underside of the deck that may indicate deterioration or corrosion of the anchorages or connections. On bridges with severely rusted forms, the forms may be removed in spot locations to facilitate inspection of the concrete.

Documentation

- For decks with bituminous overlays, see Section 5.6.4.
- For bare concrete decks and the underside of all decks, note the size and location of cracks (including "jump cracks"), spalls, delaminations, etc., along with any signs of efflorescence,

rusting, leakage, water-staining etc... Where these cannot be described narratively, provide a custom sketch showing the size and location of the defects.
- The plan sketch may also include notes for the sidewalk, curb, railing, median, parapets, lighting standards and drainage system as applicable.
- Organize deck notes in a span-by-span manner and in such a fashion that it is possible to account for "overlapping" defects on both the top and bottom of deck, so that the roll-up condition state quantities will be correct.
- Document any significant changes in condition state or discovery of critical findings and report in accordance with Section 9.3.3 and Section 5.2 of this manual.

Damage Inspections

Inspection

- Inspection methods will vary depending on the type and severity of damage. Concrete decks without a wearing surface overlay serve as the riding surface and are more susceptible to some types of damage than concrete decks with a wearing surface overlay.
- The inspection methods outlined under section: Initial/Inventory Inspections & Routine Inspections on the previous page apply here.
- Coordinate the damage inspection between the inspector, bridge owner, and any other relevant agencies to determine the scope of damage and planned inspection methods.
- Focus the inspection on directly damaged and surrounding areas that may have been indirectly damaged to determine extent and severity of damage.

Documentation

- Include thorough documentation of the condition of any deck element that has been damaged. Photographs of the damaged areas are required, and sketches are encouraged if text alone cannot easily convey the scope of the damage.
- As stated in Section 4.1.6 of this manual, information obtained during damage inspections are typically used in the decision-making process for implementing or lifting emergency load posting restrictions or bridge closures.

5.6.2.2 Report Review

- Review the inspection findings in accordance with established Quality Control and Quality Assurance procedures.
- Compare the present inspection to past inspection reports to determine if the pattern, quantity and severity of the defects found support the numerical condition rating given. Presence of any "jump cracks" will be accounted for in condition state rating of the deck per the defect table in Appendix 6A.

5.6.2.3 Maintenance Considerations

- Only perform minor maintenance that will facilitate better access and/or allow better visual evaluation of an element, such as:
    - Removing any accumulations of sanding material or debris to allow visual or sounding evaluation of the deck.
- Limit Work Candidates/Repair Suggestions to items that can generally be performed by in-house MDT Maintenance or County forces, such as:
    - Spall or delamination repairs in the deck
    - Potential Class B repairs (full depth) in the deck

   - Installation of drains or modifications of the approach or overlay to mitigate ponding on the bridge.
   - Recommendation to clear drains

- Areas of Full depth jump cracks resulting in concrete islands will be identified for repair.

Figure 5.6-2 Top of Bare Concrete Deck with Patched, Spalled and Hollow Areas.

Figure 5.6-3 Typical Underside of Concrete Deck. Note Cracking with Efflorescence and Formwork Remaining from Full Depth Patching.

5.6.3 Metal Decks

At this time, with the exception of structure metal deck pans (Corrugated Metal Decks), metal deck elements are rare in Montana.

Reference: BIRM Section 8.2

5.6.3.1 Inspection and Documentation Requirements

Initial/Inventory Inspections & Routine Inspections

Inspection

- Inspect the deck in accordance with BIRM Section 8.2.
- Inspect the top of the deck visually observing the condition. The entire top surface will be viewed from a distance that is appropriate to identify and evaluate defects consistently and accurately for weather conditions, light conditions, defect type and severity.
- Perform a “hands-on” inspection of at least 10% of the bearing areas and connections. If this inspection reveals significant defects, then additional "hands-on" inspection is required.

- Inspectors must differentiate between Stay-In-Place (SIP) forms used to construct some concrete decks versus structural corrugated steel decking (aka “Corrugated Metal Decks” or "deck pans").
    - SIP forms support the uncured concrete deck when it is originally placed. After approximately 28 days, the reinforced concrete deck hardens and becomes the structural deck system that carries the traffic loads on the bridge. At which point the SIP forms could be removed since they provide no structural support to the structure.
    - Corrugated steel flooring is only filled with asphalt, gravel, or non-structural concrete to form a wearing surface. In this case, the steel flooring is the structural deck that carries the traffic loads on the bridge.
    - Rusting of corrugated steel flooring is a more serious structural deterioration, whereas rusting of SIP forms is not structurally significant in and of itself.
    - Rusting of SIP forms may indicate leakage through the concrete deck with possible deterioration of the concrete above. Sections of SIP forms can be removed to inspect the condition of the concrete deck hidden behind the forms.

Figure 5.6-4 Underside of Corrugated Metal Deck

- Orthotropic decks have a large number of smaller members connected together to form the deck system. The connections are normally made by welding, resulting in a large number of intersecting welds. The intersecting welds, or the cope areas in members to avoid intersecting welds, will be checked for fatigue cracking that may originate at these locations.
- Open grid decks are prone to rusting because water, salt, sand, and debris can pass through the deck and collect on top of the supporting members and hold moisture that accelerates deterioration in these areas. Concentrate inspection efforts in these areas of likely deterioration where debris accumulates against bearing bars on top of the supporting members. This condition will generally be most common at the approach ends of the bridge where vehicles carry dirt, sand, and debris, etc... onto the bridge from the approaches.
- Aluminum isotropic decks are made-up of individual extrusions welded together into panels in a shop. These panels are then bolted together in the field to form the deck. Inspect the welds between extruded sections for fatigue cracking, the bolted splices between panels for proper connection, and the connection of the panels to the supporting beams where possible.

Documentation

- Deck measurement forms and new superstructure measurement forms are required during every initial inspection, every time the deck is replaced and every time the curb and/or rail is replaced or revised.
- For gravel filled decks, note any areas of thin overlay that could be caught by a grader blade and any areas with rips or holes due to blades or other damage.
- For filled grid decks with a bare top surface, note the condition of the top surface of the concrete. Note areas of heavy scale and soft concrete. Where these cannot be described narratively, provide a custom sketch showing the size and location of the defects.
- Organize deck notes in a span-by-span manner and in such a fashion that it is possible to account for "overlapping" defects on both the top and bottom of deck, so that the roll-up condition state quantities will be correct.

Damage Inspections

Inspection

- Inspection methods will vary depending on the type and severity of damage. Damage caused from vehicle live loads, such as a single cracked or broken member, may require a visual examination at only one location.

Coordinate the damage inspection between the inspector, bridge owner, and any other relevant agencies to determine the scope of damage and planned inspection methods.

Documentation

- Include thorough documentation of the condition of any deck element that has been damaged. Provide photographs of the damaged areas. Custom sketches are encouraged if text alone cannot easily convey the scope of the damage.
- As stated in Section 4.1.6 of this manual, information obtained damage inspections are typically used in the decision-making process for implementing or lifting emergency load posting restrictions or bridge closures.

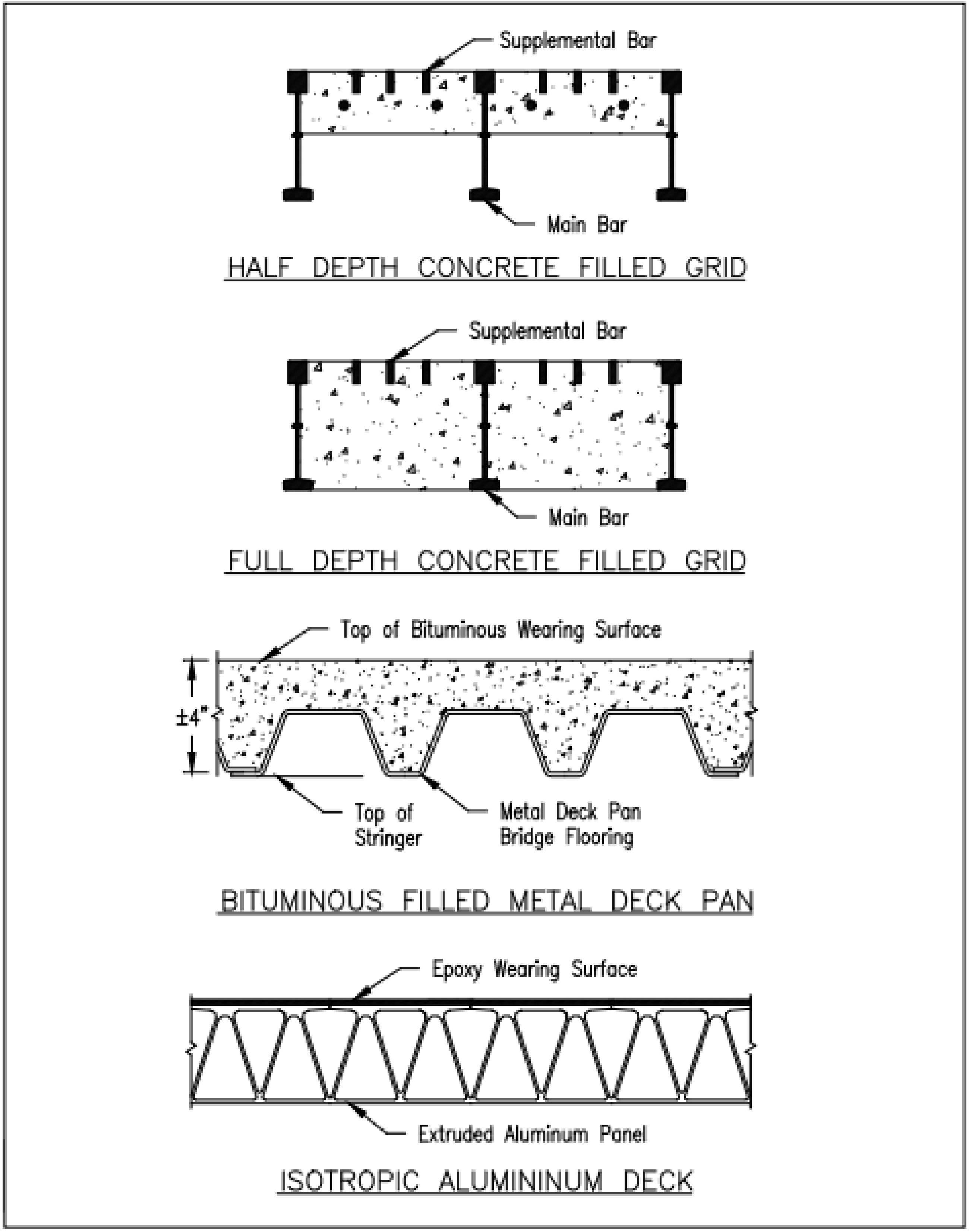
5.6.3.2 Report Review

- Review the inspection findings in accordance with established Quality Control and Quality Assurance procedures.
- Compare the present inspection to past inspection reports to determine if the pattern, quantity and severity of the defects found support the numerical condition rating given.
- If areas of severe rusting, deterioration, or damage are noted that result in steel section loss, a structural evaluation recommendation may be warranted.

5.6.3.3 Maintenance Considerations

- Only perform minor maintenance that will facilitate better access and/or allow better visual evaluation of an element, such as:
    - Removing any accumulations of sanding material or debris to allow visual or sounding evaluation of the deck.
- Limit Work Candidates/Repair Suggestions to items that can generally be performed by in-house MDT Maintenance forces, such as:
    - Repair of concrete infill or overlay material that has spalled or is unsound
    - Repair of cracked, broken, or damaged structural metal decking (grids, structural deck pans, orthotropic, etc...)

- o Loose connections between deck panels or between deck and support elements



5.6.4 Overlays (Wearing Surfaces)

Reference: BIRM Sections 8.1.2, 8.2.2, 8.3.2 and 8.4.2

Overlays are designed to provide a smooth riding surface for motorists, absorb the wear and tear of the passing vehicular and/or pedestrian traffic and protect the structural deck below**. Deterioration of the overlay, and subsequently the deck (e.g., potholes and rough surfaces), increases localized impact stresses, accelerates deterioration of the overlay and deck, and can present safety hazards to the traveling public.**

5.6.4.1 Inspection and Documentation Requirements

Initial/Inventory Inspections & Routine Inspections

Inspection

- Inspect the bridge overlay and wearing surface in accordance with BIRM Sections 8.1.2, 8.2.2, 8.3.2 and 8.4.2.
- The entire overlay will be viewed from a distance that is appropriate to identify and evaluate defects consistently and accurately for weather conditions, light conditions, defect type and severity.

For Timber Wearing Surfaces

- Look at the timber wearing surface for wear, cracking, splitting, splintering, weathering, decay (especially in areas exposed to drainage or near curbs that hold debris), impact damage (snowplows), areas of ponding, debris build-up, loose or missing fasteners, crushing, and other defects.
- Common safety hazards include loose running planks and protruding fasteners.
- Evaluate the condition of the overlay and its effectiveness in protecting the deck.
- While visually identifying defects on the top of a deck that is visually covered by an overlay, look for any defects that indicate defects in the structural deck below.

For Concrete Overlays

- Unless contract plans, previous inspection reports, or other forms of documentation explicitly indicate that a bridge has a concrete overlay, assume the concrete riding surface to be an integral part of the structural deck.
- Look at the concrete overlay for cracking, scaling, spalling, exposed reinforcement with or without corrosion (or measurable section loss), delamination, excessive wear, rutting in the wheel lines, impact damage, or other defects. Account for spalls over 2" in depth and any spall that exposes reinforcement in the overall condition rating of the deck.
- Look for flexure cracks in areas of negative bending.
- Evaluate the effectiveness of the overlay to direct water to the drainage system and whether ponding occurs. Look at areas near drainage inlets for general deterioration.
- Look at cold joints for cracking, spalling or other defects.
- Examine repaired areas to determine if repair materials are in place and functioning as designed. Hammer-tap patched areas to determine if the patch is sound and adhering to the base material.
- Areas of suspected deterioration will be inspected using physical inspection methods, such as sounding with a hammer or chain drag, to determine the limits of deterioration. (Note that traffic control may be required to implement these methods safely.)
- While visually identifying defects on the top of a deck that is visually covered by an overlay, look for any defects that indicate defects in the structural deck below.

For Polymer, Elastomeric, or other non-Cementitious Overlays

- Look at the overlay for cracking, scaling, spalling, exposed reinforcement with or without corrosion (or measurable section loss), delamination, excessive wear, rutting in the wheel lines, impact damage, or other defects. Account for spalls that extend below the overlay and into the concrete and any spall that exposes reinforcement in the overall condition rating of the deck.
- Look for flexure cracks in areas of negative bending.
- Note any reflective cracking in the overlay from Class A or B repairs in the concrete deck under the overlay.
- Evaluate the effectiveness of the overlay to direct water to the drainage system and whether ponding occurs. Inspect areas near drainage inlets for general deterioration.
- Look at cold joints for cracking, spalling or other defects.
- Examine repaired areas to determine if repair materials are in place and functioning as designed. Hammer-tap patched areas to determine if the patch is sound and adhering to the base material.
- Areas of suspected deterioration or delamination will be inspected using physical inspection methods, such as sounding with a hammer or chain drag, to determine the limits of deterioration and delamination. (Note that traffic control may be required to implement these methods safely.)
- While visually identifying defects on the top of a deck, look for any defects that indicate defects in the structural deck below.

For Bituminous Concrete (Asphalt) Overlays

- Look at bituminous concrete overlays for cracking, rutting, excessive wear, raveling, impact damage, deflections under live load, potholes, and other defects.
- Look at areas near drainage inlets for general deterioration.
- Look for flexure cracks in areas of negative bending and near joints.
- Evaluate the effectiveness of the overlay to direct water to the drainage system and whether ponding occurs.
- Measure the curb reveal at spot locations to verify the thickness of the bituminous concrete overlay. If the field calculated thickness of the bituminous concrete layer, based on the curb reveal, is greater than plans or maintenance records indicate, perform additional testing to determine the actual overlay thickness for dead load analysis and the need for a new load rating will be evaluated.
- While visually identifying defects on the top of a deck that is visually covered by an overlay, look for any defects that indicate defects in the structural deck below.

Documentation

- Document defects such as cracking, spalling, potholes, rutting, excessive wear, raveling, impact damage, deflection under live load, exposed reinforcing bars, scaling, decay, pest infiltration, weathering, debris build-up, etc. Note the surface area dimensions, depth of loss, and the relative location on the deck for all defects.
- Document repairs and evaluate the condition of the repair and whether the repair material is adhering to the base material and performing as intended.
- Document all ponding on wearing surface due to depressions, spalls or potholes and whether debris build-up prevents adequate drainage.
- Provide a custom sketch of defects when a written description is not sufficient to convey all necessary information. This plan sketch may also include notes for the sidewalk, curb, railing, median, parapets, lighting standards and drainage system as applicable.

- Provide a plan view photo of the deck area showing the locations of all significant problems or problems that cannot be adequately documented with words. Wearing Surfaces are Bridge Damage Inspections

Damage Inspections

Inspection

- Inspection methods will vary depending on the type and severity of damage. Overlays that have been damaged due to fuel spills or fire damage may require a widespread visual and physical examination including sounding and probing to determine the integrity of the overlay. Isolated defects such as cracks, potholes, and raveling may require a visual examination at only a few locations.

Documentation

- Include thorough documentation of the condition of any overlay element that has been damaged. Photographs of the damaged areas are required, and custom sketches are encouraged if text alone cannot easily convey the scope of the damage.

5.6.4.2 Report Review

- Review the inspection findings in accordance with established Quality Control and Quality Assurance procedures.
- Cross reference the inspection report, inspection field notes and photographs to ensure they are mutually supportive of their documentation.
- Compare past and present inspection reports to determine if patterns of deterioration or progressive deterioration are taking place.

5.6.4.3 Maintenance Considerations

- Only perform minor maintenance that will facilitate better access and/or allow better visual evaluation of an element, such as:
  - Removing any accumulations of sanding material or debris to allow visual or sounding evaluation of the deck.
- Limit Work Candidates/Repair Suggestions to items that can generally be performed by in-house MDT Maintenance forces, such as:
  - Repair or replacement of timber running planks or loose or protruding connectors.
  - Repair of concrete, polymer, or asphalt spalls or delaminations.
  - Installation of drains or modifications of the approach or overly to mitigate ponding on the bridge.
  - Recommendation to clear drains.

5.6.5 Curbs

Curbs are generally meant to delineate a travelway and may fall into one of multiple categories, depending on their design. Non-mountable curbs are designed to deflect errant vehicles and keep them within the travel lane boundaries of the bridge. Mountable curbs are designed so that vehicles can cross them readily when required. Barrier curbs are relatively high and steep-faced, designed to inhibit or at least discourage vehicles from leaving the roadway.

In general, mountable curbs will have the following features:

- Front face sloped to some degree.
- Top corner well rounded.

Typical bituminous concrete lip curbing is considered mountable.

The following curb features are typically associated with barrier curbs (non-mountable):

- Concrete curbs that have vertical or close to vertical face.
- Jersey type barriers.

Reference: BIRM Section 4.1.7

5.6.5.1 Inspection and Documentation Requirements

Initial/Inventory Inspections & Routine Inspections

Inspection

- Inspect the curbs in accordance with BIRM Section 4.1.7.
- Look at curb components from a distance that is appropriate to identify and evaluate defects consistently and accurately for weather conditions, light conditions, defect type and severity.
- Inspect the curbs for defects such as:
  - Concrete - Cracked, scaled, spalled, delaminated, displaced, or crushed concrete.
  - Steel - Rust, section loss, cracks and loose, bent or displaced members.
  - Timber - Fungus growth, fire damage, weathering, warping, splitting, checking, crushed or displaced members and chemical damage. Check for adequate attachment to the deck.
- Look at curbs for impact damage or elements that stick up presenting tripping hazards to pedestrians or snagging hazards to passing traffic.
- Look at the curb/overlay interface for cracks or openings through which water may pass to the deck.
- Perform spot measurements of the curb reveal to determine if it is constant over the length of the bridge and consistent with the as-built value.
- Look at expansion joints for exposed blunt ends that could present a hazard to passing vehicles. If plates, covers, or other devices are in place to provide continuity between the two curbs, check for adequate anchorage.
- Evaluate the ability of the curb to direct water runoff to the drainage system and whether there is evidence, like dampness or staining, indicating leakage occurs through the curb or curb/deck interface.

Documentation

- Document defects found on the curbs. These notes may be incorporated into the field notes for the railing. Documentation will include the size, description and relative location on the bridge for the noted defect.
- Note the condition of curb expansion devices and whether the joint opening seems reasonable for the ambient temperature.
- Document the current condition of previously noted problems or defects.

Damage Inspections

Inspection

- Inspection methods will vary depending on the type and severity of damage. An extensive visual and physical inspection may be required after a significant traffic accident has occurred and caused widespread damage to the curbs. An isolated visual inspection may suffice to inspect the condition of curb after an incident has occurred causing localized damage.
- Coordinate the damage inspection between the inspector, bridge owner, and any other relevant agencies to determine the scope of damage and planned inspection methods.

Documentation

- Include thorough documentation of the condition of any curb element that has been damaged. Photographs of the damaged areas are required and custom sketches are encouraged if text alone cannot easily convey the scope of the damage.

5.6.5.2 Report Review

- Review the inspection findings in accordance with established Quality Control and Quality Assurance procedures.
- Cross reference the inspection report, inspection field notes, and photographs to ensure they are mutually supportive of their documentation.
- Review the inspection findings to determine if any defects exist that present a safety hazard to the traveling public (vehicular or pedestrian).
- Check current measurements against the last inspection to verify if the deck has been overlayed. If the deck has a new overlay since the previous inspection, the need for a new load rating will be evaluated.

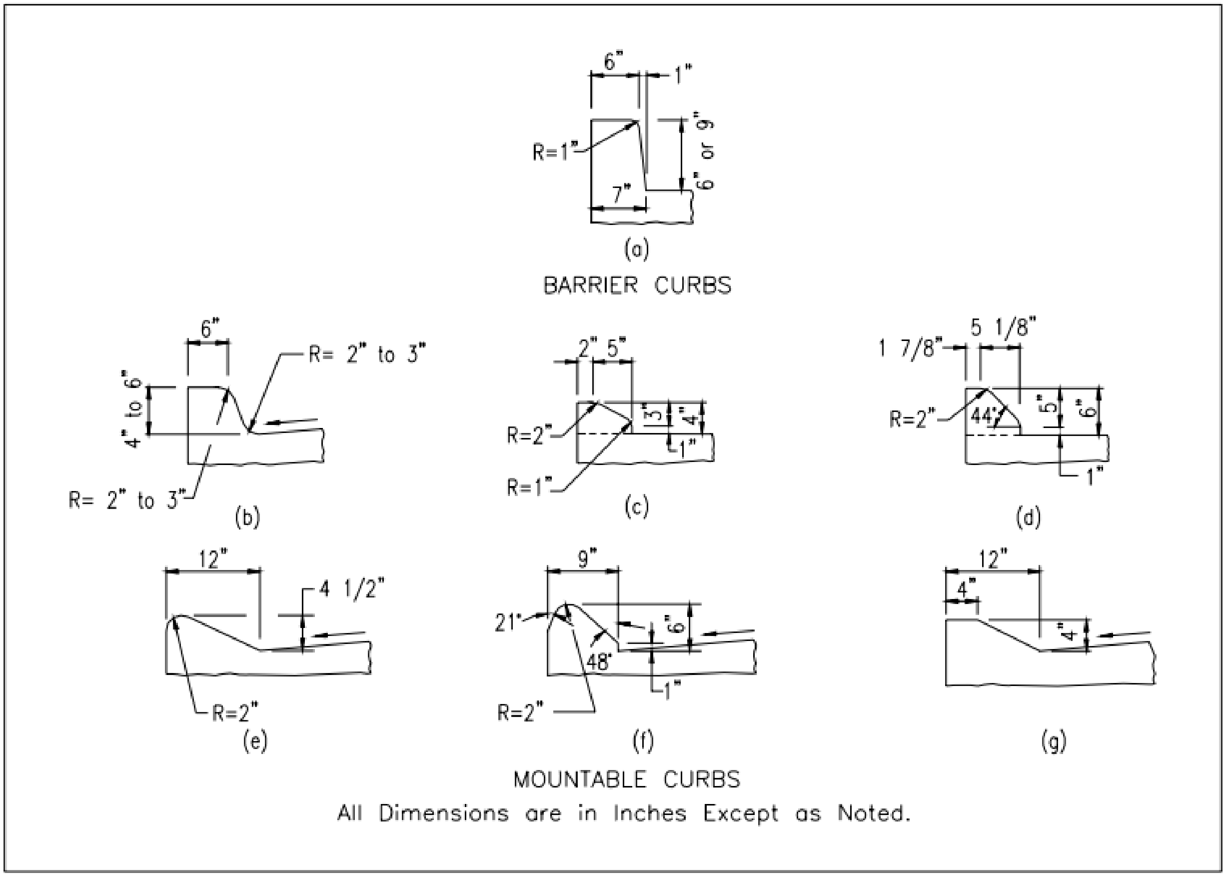


Figure 5.6-5 Types of Mountable Curbs

Figure 5.6-6 Typical Concrete Curb with Safety Walk

5.6.5.3 Maintenance Considerations

- Only perform minor maintenance that will facilitate better access and/or allow better visual evaluation of an element, such as:
  - Removing any accumulations of sanding material or debris to allow visual or sounding evaluation of the curbs.
- Limit Work Candidates/Repair Suggestions to items that can generally be performed by in-house MDT Maintenance forces, such as:
  - For non-mountable curbs, any condition such as spalled or cracked stone or concrete, decayed, infested or split timber, rusted steel or other defects that negate the ability of the curb to defect errant vehicles.
  - For all curbs, any curb that is deteriorated to the point where they are breaking up or displaced into traffic and presenting a potential hazard to vehicles or pedestrians.
  - Impact damage
  - Damaged curb joints with metal assemblies.

5.6.6 Medians

Reference: BIRM Section 8.6.6

5.6.6.1 Inspection and Documentation Requirements

Initial/Inventory, Routine, Damage, Follow-up Inspections

Inspection & Documentation

- Inspect the median system in accordance with the Inspection and Documentation Requirements, Report Review and Maintenance Considerations guidelines as outlined below:
  - Median Curbs: Use Section 5.6.5 Curbs
  - Median Barriers: Use Section 5.6.8 Parapets or Section 5.6.9 Railings
  - Asphalt Raised Median: Use Section 5.6.4 Overlays
  - Concrete Raised Median: Use Section 5.6.7 Sidewalks
  - Steel Grid Median: Use Section 5.6.3 Metal Decks

Deterioration on the underside of a median is typically part of the structural deck system and will be evaluated as part of that inspection.

5.6.7 Sidewalks

Reference: BIRM Section 4.1.7

5.6.7.1 Inspection and Documentation Requirements

For all sidewalk inspection and documentation, consult the requirements under decks, as Montana considers sidewalks as part of the deck.

Figure 5.6-7 Concrete Sidewalk with Pedestrian Fence and Traffic Divider.

5.6.8 Parapets

Reference: BIRM Section 8.6.5

Parapets are designed to redirect errant vehicles to protect the vehicle occupants or pedestrians on walkways outside of the travel way. Deterioration, spalls, impact damage, impact displacement, loose joint assemblies, or other defects may diminish the ability of the parapet to perform its design function of redirecting errant vehicles.

5.6.8.1 Inspection and Documentation Requirements

Initial/Inventory Inspections & Routine Inspections

Inspection

- Inspect all parapet components in accordance with BIRM Section 8.6.5.
- Look at parapets from a distance that is appropriate to identify and evaluate defects consistently and accurately for weather conditions, light conditions, defect type and severity. Perform a “hands-on” inspection of all problem areas.
- Look at the parapet system for cracking, scaling, delamination, spalling, exposed reinforcement, or other defects, such as rusting on steel parapets.
- Look at parapet components for impact damage, and displacements that present exposed, blunt ends or snagging hazards to passing vehicles.
- Look at parapet expansion joint devices for integrity and proper function. Note if expansion joint elements are missing, exposing the blunt ends of the parapets on either side of the joint.
- Look for openings at joints that may be large enough to constitute a pedestrian hazard (especially for children). Consider any opening greater than 4" in parapets that form part of a pedestrian barrier along sidewalks or in areas where there is significant pedestrian traffic to be a hazard.

Documentation

- Document defects found on the parapets. Incorporate these notes onto the custom sketches made as part of the top of deck inspection if necessary. Documentation will include the size and relative location along the bridge of noted defects.
- Document the condition of the parapet expansion joint devices and whether the joint opening appears reasonable for the ambient temperature.
- Document the current condition of all previously noted defects.

Damage Inspections

Inspection

- Inspection methods will vary depending on the type and severity of damage. An extensive visual and physical inspection may be required after a significant traffic accident has occurred and caused widespread damage to the parapets. An isolated visual inspection may suffice to inspect the condition of a parapet after an incident has occurred causing localized damage.
- Coordinate the damage inspection between the inspector, bridge owner, and any other relevant agencies to determine the scope of damage and planned inspection methods.

Documentation

- Include thorough documentation of the condition of any parapet element that has been damaged. Provide photographs of the damaged areas and custom sketches are encouraged if text alone cannot convey the scope of the damage.

5.6.8.2 Report Review

- Review the inspection findings in accordance with established Quality Control and Quality Assurance procedures.
- Cross reference the inspection report, inspection field notes, and photographs to ensure they are mutually supportive of their documentation.
- Review the inspection findings to determine if any defects exist that present a safety hazard to the traveling public (vehicular and/or pedestrian).
- Review the parapet configuration for compliance with current MDT standards for traffic and/or pedestrian barriers depending on bridge site usage and note the results of the review.

Figure 5.6-8 Concrete Parapet with Metal Pipe Railing. Note Spalling with Exposed Reinforcing Steel.

5.6.8.3 Maintenance Considerations

- Only perform minor maintenance that will facilitate better access and/or allow better visual evaluation of an element, such as:
  - Removing any accumulations of sanding material or debris to allow visual or sounding evaluation of the deck.
- Limit Work Candidates/Repair Suggestions to items that can generally be performed by in-house MDT Maintenance forces, such as:
  - Spalls, impact damage, or delamination repairs in the parapet concrete.
  - Loose or protruding joint assembly components
  - Loose, damaged, or protruding pedestrian rail components attached to the parapet.

5.6.9 Bridge Railings

Reference: BIRM Section 8.6

Railings are designed to deflect errant vehicles and keep them within the travel lane boundaries of the bridge. They rely on their position, integrity, and firm attachment to the deck or sidewalk to perform this function.

5.6.9.1 Inspection and Documentation Requirements

Initial/Inventory Inspections & Routine Inspections

Inspection

- Inspect all railings in accordance with BIRM Section 8.6.
- Look at rail components from a distance that is appropriate to identify and evaluate defects consistently and accurately for weather conditions, light conditions, defect type and severity. Perform a “hands-on” inspection of problem areas.
- Look at components of the railing system for cracks, scaling, spalls, rust, section loss, loose or broken fasteners, cracked welds, weathering, splitting, checking, impact damage, or other defects.
- Look for impact damage, missing components or displacement that present exposed, blunt ends or snagging hazards to passing vehicles and/or pedestrians.
- Look for openings at joints that may be large enough to constitute a pedestrian hazard (especially for children). Consider any opening~~s~~ greater than 4" in parapets that form part of a pedestrian barrier along sidewalks or in areas where there is significant pedestrian traffic to be a hazard.
- Look at rail post anchorages to determine if the railing is securely fastened to the deck or parapet.
- Look at railing expansion joint devices or end treatments to see if they are in place and functioning properly.
- Look for any dips or raised areas along the length of the railing. These could be indicative of a larger problem with the superstructure or substructure.

Documentation

- Document defects found on the railings. Incorporate these notes onto the custom sketches made as part of the top of deck inspection if necessary. Documentation will include the size and relative location along the bridge of noted defects.
- Document the condition of railing expansion joint devices and end treatments, and whether the joint opening appears appropriate for the ambient temperature.
- Document the current condition of all previously noted defects.

Damage Inspections

Inspection

- Inspection methods will vary depending on the type and severity of damage. An extensive visual and physical inspection may be required after a significant traffic accident has occurred and caused widespread damage to the bridge railings. An isolated visual inspection may suffice to inspect the condition of a bridge railing after an incident has occurred causing localized damage.
- Coordinate the damage inspection between the inspector, bridge owner, and any other relevant agencies to determine the scope of damage and planned inspection methods.

Documentation

- Include thorough documentation of the condition of any parapet element that has been damaged. Provide photographs of the damaged areas and custom sketches are encouraged if text alone cannot easily convey the scope of the damage.

5.6.9.2 Report Review

- Review the inspection findings in accordance with established Quality Control and Quality Assurance procedures.
- Cross reference the inspection report, inspection field notes and photographs to ensure they are mutually supportive in their documentation.
- Review the inspection findings to determine if any defects exist that present a safety hazard to the traveling public (vehicular and pedestrian).

Figure 5.6-9 Steel Bridge Railing Post with Corrosion

5.6.9.3 Maintenance Considerations

- Only perform minor maintenance that will facilitate better access and/or allow better visual evaluation of an element, such as:
  - Removing any accumulations of sanding material or debris to allow visual or sounding evaluation of the deck.
- Limit Work Candidates/Repair Suggestions to items that can generally be performed by in-house MDT Maintenance forces, such as:
  - Spalls, impact damage, or delamination repairs in concrete.
  - Rail post or rail repair of impact damage or deterioration.
  - Debris removal from rail post base areas.

Figure 5.6-10 Pedestrian Fence atop Concrete Parapet.

5.6.10 Deck Joints

Reference: BIRM Section 8.5

Deck joints are necessary elements on most bridges to ensure that the bridge can function properly under the stress of external forces. They allow the bridge to expand and contract due to the daily and seasonal temperature changes and allow for rotations of the superstructure and deck under live loads.

Although the condition of bridge joints are not directly incorporated into the condition rating of the deck, superstructure, and substructure, their condition and ability to perform their designed function can influence those ratings.

5.6.10.1 Inspection and Documentation Requirements

Initial/Inventory Inspections & Routine Inspections

Inspection

- Inspect all joints in accordance with BIRM Section 8.5.
- Look at joint components on top of the deck from a distance that is appropriate to identify and evaluate defects consistently and accurately for weather conditions, light conditions, defect type and severity. Inspect any problem areas found up-close and from the underside, if necessary.
- Look at all joints and supporting elements for deterioration due to corrosion, impacted rust, cracks, excessive vibration.
- Check joints for loose fasteners, loose floorplates, loose assemblies, or damaged, or broken components. These may present hazards to the traveling public in the form of protrusions that

may puncture tires or become snagging hazards, or sections of which may come loose and present an impact hazard.

- Look for cracked welds.
- Look for impact damage from snowplows.
- Look to see if the joint is paved over and the condition of the pavement above the joint.
- Look for vertical displacement across the two halves of the joint in the direction of traffic.
- Look to see if open joints are clogged with debris that may affect the ability of the joint to open and close with expansion and contraction of the bridge or to pass water to the drainage system below.
- Look to see if joint sealant is in place and operating as designed, if there are signs of leakage through the joint (closed joint), or any other notable defects. Also observe if water backs up around the joint on the deck due to the inadequacy or blockage of the primary drainage system.
- Look for ruptured or torn seals, glands, and segmental components.
- Look for any concrete deterioration adjacent to the joint supports or faces. Sound the concrete around the joints to check for delamination.
- Listen for any unusually loud noises when traffic passes over the joint that indicates loose elements or full assemblies.
- Look at the joint when traffic passes over for excessive movement and deflection.
- Look to see if the joint gap is what you would expect for the current ambient temperature (i.e. hot weather = smaller gap; cold weather = larger gap). An excessively open or closed joint for the ambient temperature condition may indicate possible problems with the expansion bearings, movement of the substructure, or improper installation of the joint. The existence of this problem warrants further investigation such as frozen, damaged, or failed bearings, other joints that are blocked and forcing all movement to another joint, bents or abutments that are shifting or settling, etc.

Documentation

- Report joint devices as a Critical Finding that present a current or imminent safety hazard such as steel assembly joints or steel joint headers that are excessively loose or broken and that move under traffic and/or have the potential to break free.
- Document any defects discovered during the inspection
- Document all steel losses by noting the area and depth of the loss as well as its relative location along the length of the joint measured from a fixed point. Steel losses include scrapes in the steel from snowplows.
- Document locations of all loose bolts, rivets, or broken welds found.
- Document locations and lengths of all fatigue cracks found. Mark these locations on the joint with a permanent marker. Note the date found and the extent of the crack in such a manner that subsequent inspections may determine the extent of crack propagation.
- Document any deteriorated conditions in the concrete adjacent to the steel joint assemblies or steel headers where they are anchored.
- Document any increased quantity or size of defects that have changed since the last inspection. If the condition rating has changed from the last inspection, provide a photograph and explanation of why the rating has changed in the inspection report.
- Describe the current condition of all previously noted problems so a rate of deterioration can be established for monitoring purposes.

Damage Inspections

Inspection

- Inspection methods will vary depending on the type and severity of damage. An extensive visual and physical inspection may be required after a significant traffic accident has occurred and caused widespread damage to the deck joints. An isolated visual inspection may suffice to inspect the condition of a deck joint after an incident has occurred causing localized damage.
- Coordinate the damage inspection between the inspector, bridge owner, and any other relevant agencies to determine the scope of damage and planned inspection methods.

Documentation

- Include thorough documentation of the condition of any parapet element that has been damaged. Provide photographs of the damaged areas and custom sketches are encouraged if text alone cannot easily convey the scope of the damage.

5.6.10.2 Report Review

- Review the inspection findings in accordance with established Quality Control and Quality Assurance procedures.
- Cross reference the inspection report, inspection field notes and photographs to ensure they are mutually supportive of their documentation.
- Compare past and present inspection reports to determine if patterns of deterioration or progressive deterioration are taking place.

5.6.10.3 Maintenance Considerations

- Only perform minor maintenance that will facilitate better access and/or allow better visual evaluation of an element, such as:
  - Removing any accumulations of sanding material or debris to allow visual or sounding evaluation of the joints.
- Limit Work Candidates/Repair Suggestions to items that can generally be performed by in-house MDT Maintenance forces, such as:
  - Repair of damaged, loose, or cracked steel joint assemblies, steel joint headers, or individual components of steel joint assemblies. This also includes propagation of previously noted fatigue cracks.
  - Repair of damaged or deteriorated concrete anchoring joint assemblies.
  - Removal of debris built up in joint openings.
  - Repair of concrete joint headers.
  - Replacement of pourable or compression joint seals or any joint that shows signs of leaking and is contributing to the accelerated deterioration of beams, bearings, or substructure components.

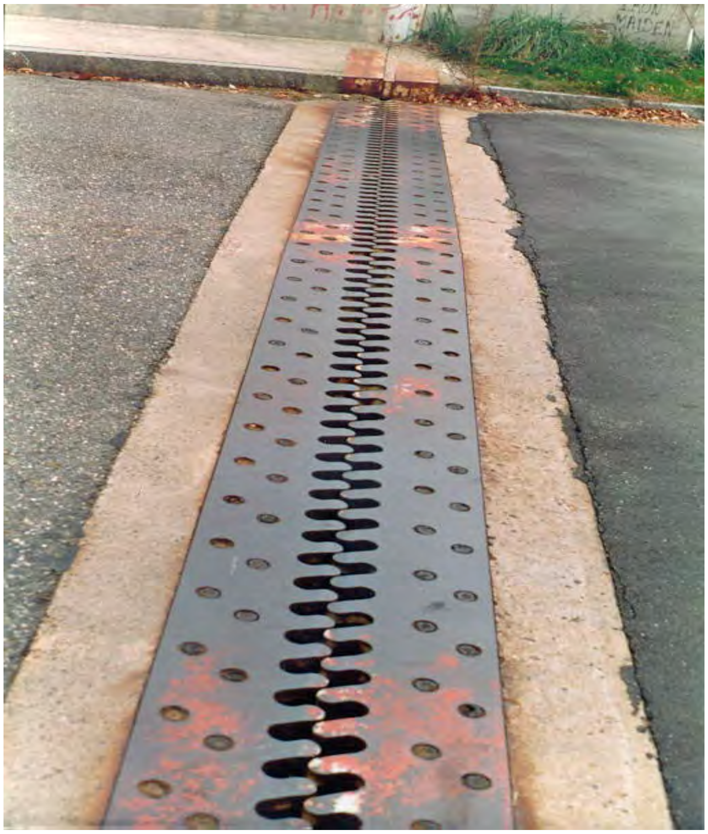


Figure 5.6-11 Steel Finger Joint.

Figure 5.6-12 Asphaltic Plug Expansion Joint.

Figure 5.6-13 Modular Type Expansion Joint Replacement.

5.7 Superstructure Inspection

5.7.1 Bearings

References: BIRM Chapter 13
MDT Hands-On Inspection of Steel Members

Expansion Bearings

Bridges are continually moving due to thermal expansion and contraction, deflections under loads, unanticipated substructure movements, and other forces. These movements are accommodated by bearings. Expansion bearings must be free to move as designed if the bridge is to function properly. Movement may be absorbed within the structure if the span length is short. However, frozen bearings on longer bridges will impart thermal forces into the bridge members and force the movement to occur at points where movement was not anticipated. One or more spans may move together, exerting forces on abutments, piers, or connections for which they were not designed. Nearly all types of bearings are susceptible to freezing. Freezing, as applied to bridge bearings, means that movement has been prevented by corrosion, mechanical binding, intrusion of dirt or other interference to the point that the bearing does not operate properly or is held in a rigid condition. Normally, a frozen bearing will exhibit no signs of movement. Movement can usually be detected by the presence of polished surfaces on the visible sliding surfaces, broken paint between the fixed and moveable part of the bearing, crushed material under a rocker bearing, etc. The only true method to determine if a bearing is frozen, however, is to compare bearing measurements taken at different temperatures (i.e., measurements taken during warm weather will be different from those taken during cold weather.)

The most common types of expansion bearings are self-lubricating bronze sliding bearings, steel rocker bearings, elastomeric bearings and pot bearings. Another special type of bearing seen on a number of structures is the pin and hanger bearing. Examples of the typical bearings are shown in Figure 5.7-1 to Figure 5.7-5 and Figures 13.1.1 to 13.3.30 in FHWA BIRM Chapter 13.

5.7.1.1 Inspection and Documentation Requirements

Initial/Inventory Inspections & Routine Inspections

Inspection

- Inspect all the bearings in accordance with BIRM Chapter 13.
- Illustrations of several bearing types and measurement forms are provided below for reference and use.
- Bearing areas must be cleaned, as necessary, or referred to Maintenance for cleaning, if excessive, to permit an adequate inspection of the bearings.
- A random sampling (approximately 25%) of the bearing anchor bolts will be tapped with a hammer to determine if they are intact and solidly anchored to the substructure. The frequency of sampling will be increased if defective bolts are found.

Documentation

- The condition of fixed bearings and elastomeric bearings may be described narratively on the inspection forms or on framing plans if included. Special or unusual problems like significant loss of bearing area or broken/cracked components will be sketched and photographed.
- The bearing conditions may be described directly in the BrM field. For bearings with a CS-4 due to Movement, Alignment or Loss of Bearing Area within the bearing, the above bearing measurement forms will be used to document the movement.
- Representative photographs will be included for bearings that appear to be frozen, are CS-4, or exhibit major deficiencies.
- Significant changes in condition state or discovery of critical findings will be documented and reported in accordance with Section 9.3.3 and Section 5.2 of this manual.

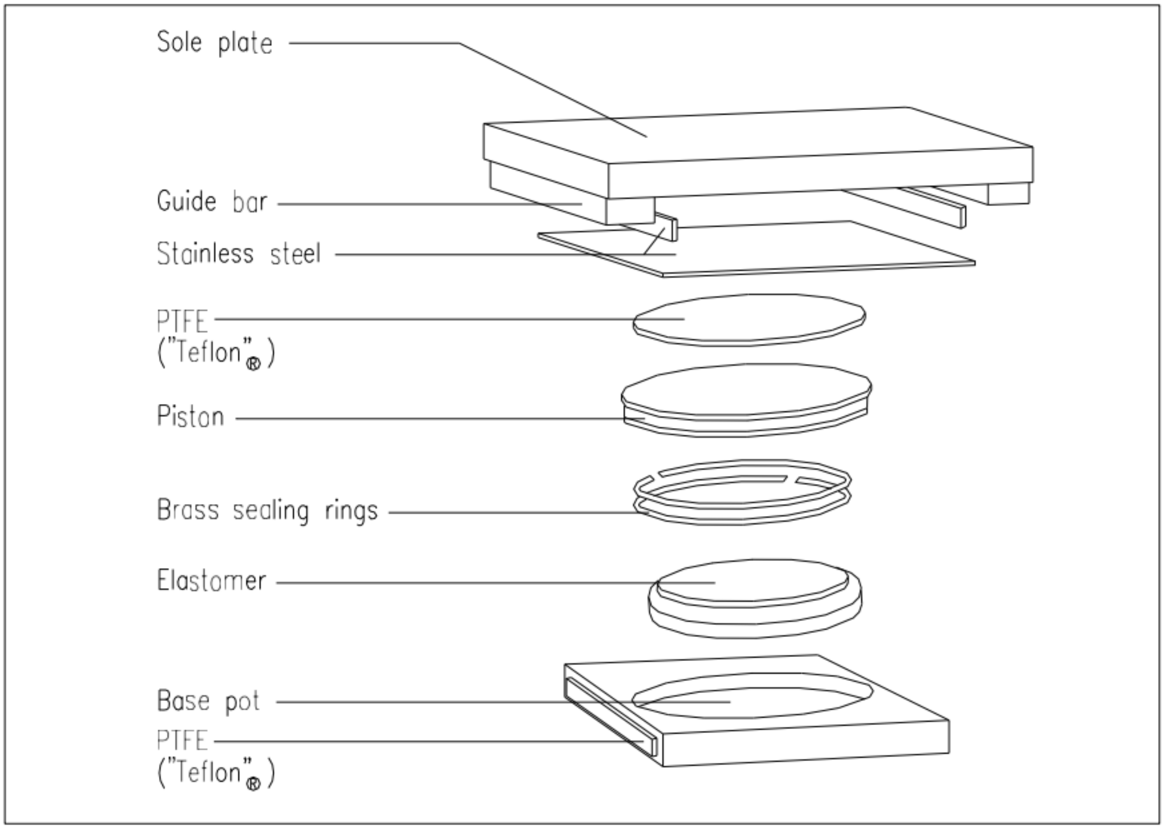


Figure 5.7-1 Typical Guided Pot Bearing Components

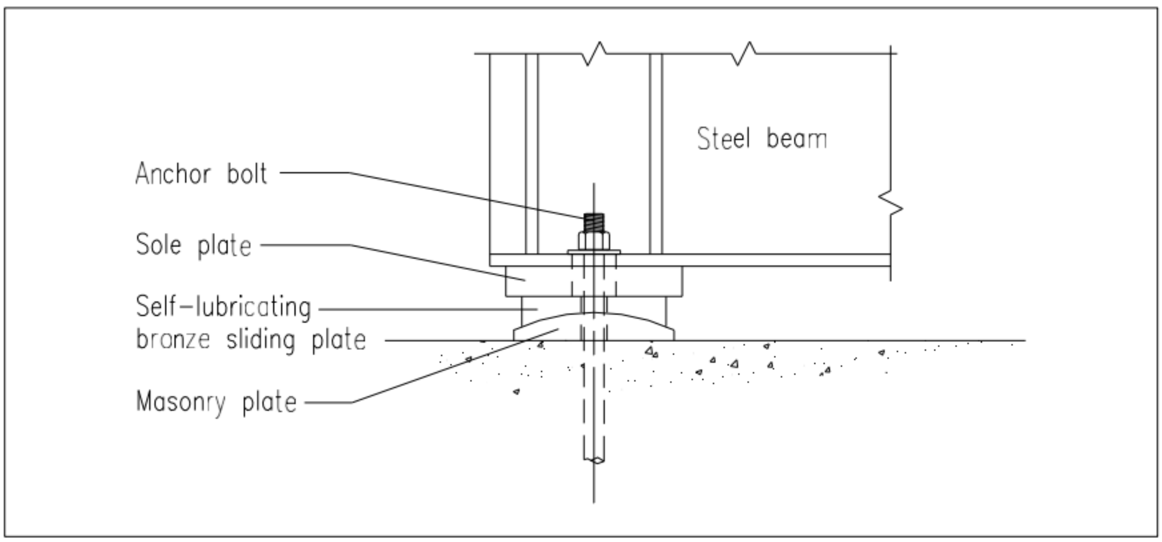


Figure 5.7-2 Typical Bronze Sliding Plate Bearing

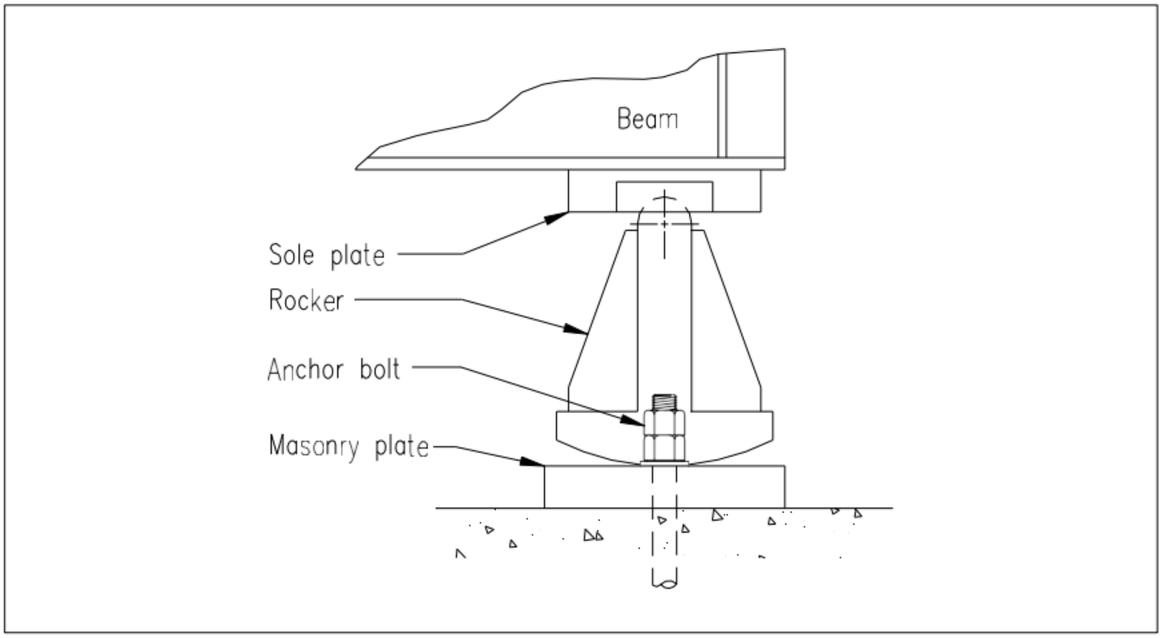


Figure 5.7-3 Typical Rocker Bearing

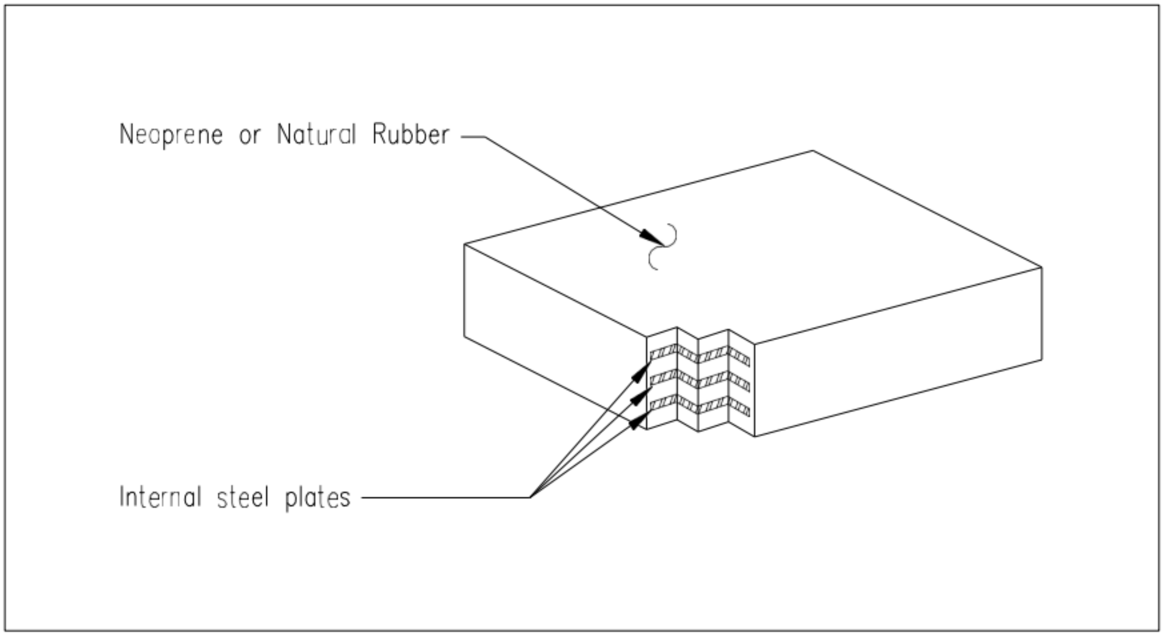


Figure 5.7-4 Typical Steel Reinforced Elastomeric Bearing

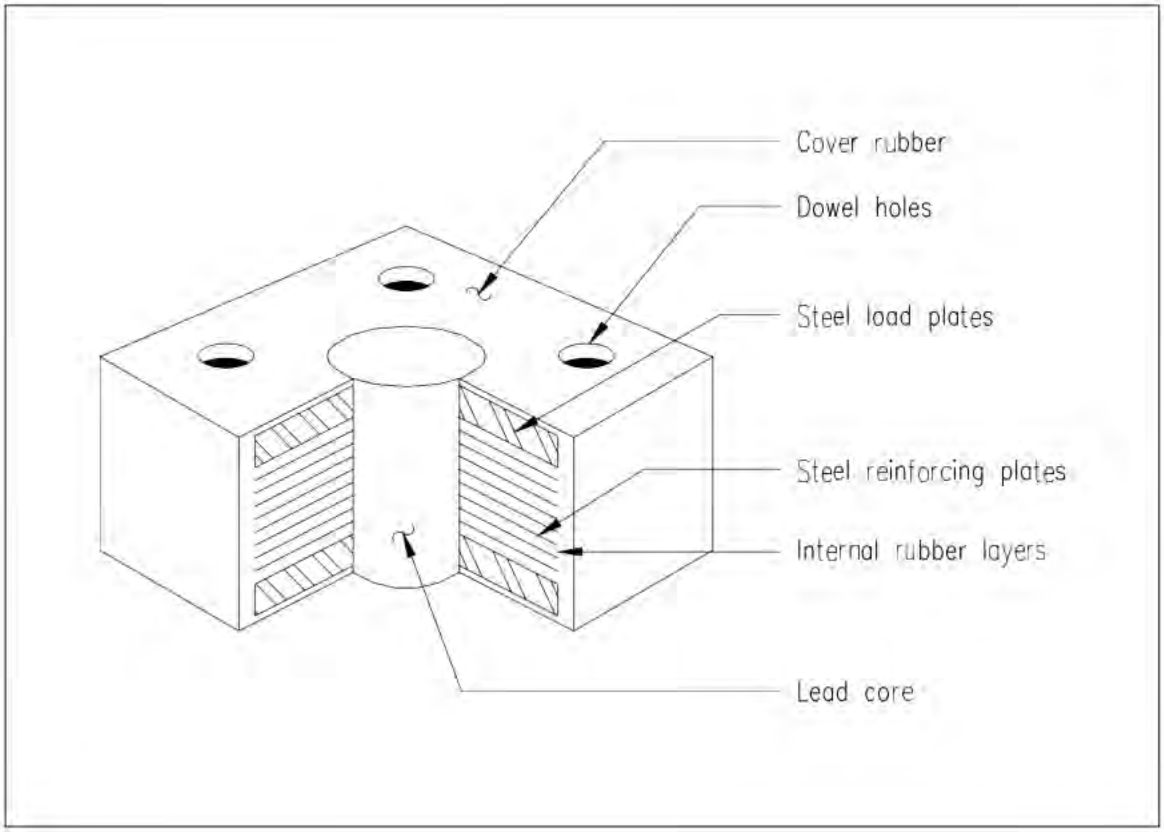
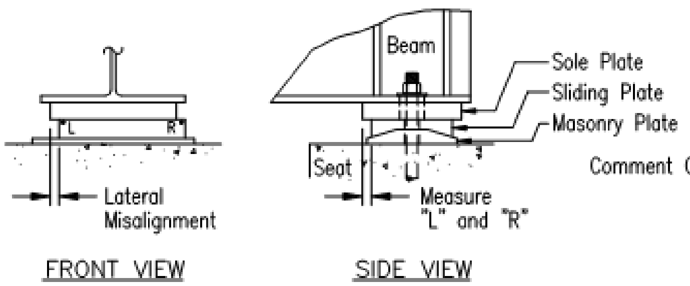


Figure 5.7-5 Dynamic Isolation Bearing for Seismic Protection

FIELD NOTES	BRIDGE NO.	DATE:
	CREW:	SHEET

SLIDING BEARING MEASUREMENTS

Form BRI-14



Span No. = _____

Substructure Unit = _______________

Temperature = ____°F

Comment On:
- Presence of keepers or work done on bearings.
- Undermining of bearing. Attach sketch with dimensions.
- Cracking of plates or welds.
- Condition of anchor bolts.

Beam	Movement				Condition			Comments
	"L"	"R"	Mode Exp. or Contr.	Lateral Misalign.	Bearing Frozen?	Normal Mov't?	Rust ? H/M/L	

Figure 5.7-6 Sliding Bearing Measurement Form

FIELD NOTES	BRIDGE NO.	DATE:
	CREW:	SHEET

ROCKER BEARING MEASUREMENTS

Span No. = _____

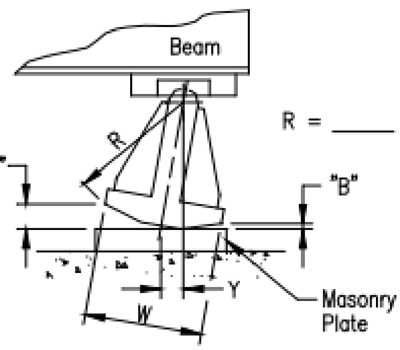
Substructure Unit = ____________________

Temperature = ____°F

$\theta = \sin^{-1}(F-B)/W$

$Y = R \tan\theta$

The "Front" of the bearing is the side facing the fixed bearing.



R = _____

W = _____

NOTE:

"F" & "B" should be measured at the left side corners of the rocker or on the side closest to to the front face of the substructure on skewed bridges.

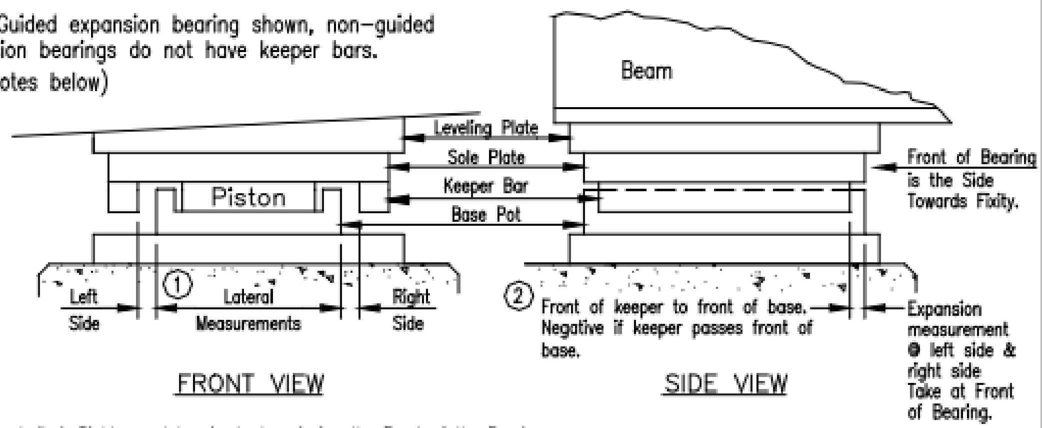
Beam	"F"	"B"	Y	Cont. or Exp.	Comments

Figure 5.7-7 Rocker Bearing Measurement Form

FIELD NOTES	BRIDGE NO.	DATE:
	CREW:	SHEET

POT BEARING MEASUREMENTS

Note: Guided expansion bearing shown, non–guided expansion bearings do not have keeper bars. (see notes below)



① –Left & Right are determined when facing the Front of the Bearing.
–For non–guided bearings, measure from side of sole plate to side of piston @ center line of piston.

② –For non–guided bearings, measure expansion from front of sole plate to front of piston @ center line of bearing.

Span No. & Substructure Unit = ______________________ Temperature = ____°F

Beam	Expansion			Lateral		Comments
	Exp. Measurement		Side of Brg.	Left	Right	
	L	R	(N,S,E,W)			

Figure 5.7-8 Pot Bearing Measurement Form

Damage Inspections

Inspection

- Inspection methods will vary depending on the type and severity of damage. Damage areas may be caused by vehicle impact, earthquake, or extreme weather events. This is not an exhaustive list of the causes of damage.
- The damage inspection will be coordinated between the inspector, bridge owner, and any other relevant agencies to determine the scope of damage and planned inspection methods.

Documentation will include, but not be limited to:

- Documentation in the inspection report of the condition of any bearing element that has been damaged. Photographs of the damaged bearings are required and sketches or measurement forms are encouraged if description alone cannot easily convey the scope of the damage.
- As stated in Section 4.1.6 of this manual, damage inspections are typically used in the decision-making process for implementing or lifting emergency load posting restrictions or bridge closures.

5.7.1.2 Report Review

- Review the inspection findings in accordance with established Quality Control and Quality Assurance procedures.
- The inspection report reviewer will determine if the pattern, quantity, and severity of the deteriorations found support the numerical condition rating given. The reviewer will compare the present inspection report to past reports.
- When taken, expansion bearing measurements will be compared to those in the last inspection report to determine if the change in measurement based on the difference in temperatures at the time the bearings were measured is reasonable.
- Comparison of bearing measurements will determine if there is lack of movement or a progressive movement taking place.

5.7.1.3 Maintenance Considerations

- Bearings must be relatively clean to function properly. Accumulated debris on a bridge seat, that tends to interfere with a bearing's movement and hold moisture around the bearing, will be removed by the inspector when possible; otherwise it will be included in a work item and debris removed by Maintenance.
- Normally, frozen bearings will develop irregularities, along their movement surfaces, that cause mechanical binding and prevent normal movement. Simply cleaning these bearings does not usually remove or correct the irregularities that cause the binding and, therefore, is not normally effective unless the deterioration is minor.
- On bridge spans under 100’, the amount of thermal movement is less than on longer spans and may be accommodated in the superstructure. If there are no signs of distress, the replacement of frozen bearings may not be justified.
- On bridges over 100’ or where a large number of bearings appear to be frozen, replacement of the bearings with suitable type bearings will be requested.

Figure 5.7-9 Over Extended Rocker Bearing.

- Note: Front of Rocker in Contact with Underside of Sole Plate.

Figure 5.7-10 Bronze Sliding Plate Bearing with a Gap

Figure 5.7-11 Retrofit Detail. Elastomeric Bearing Installed

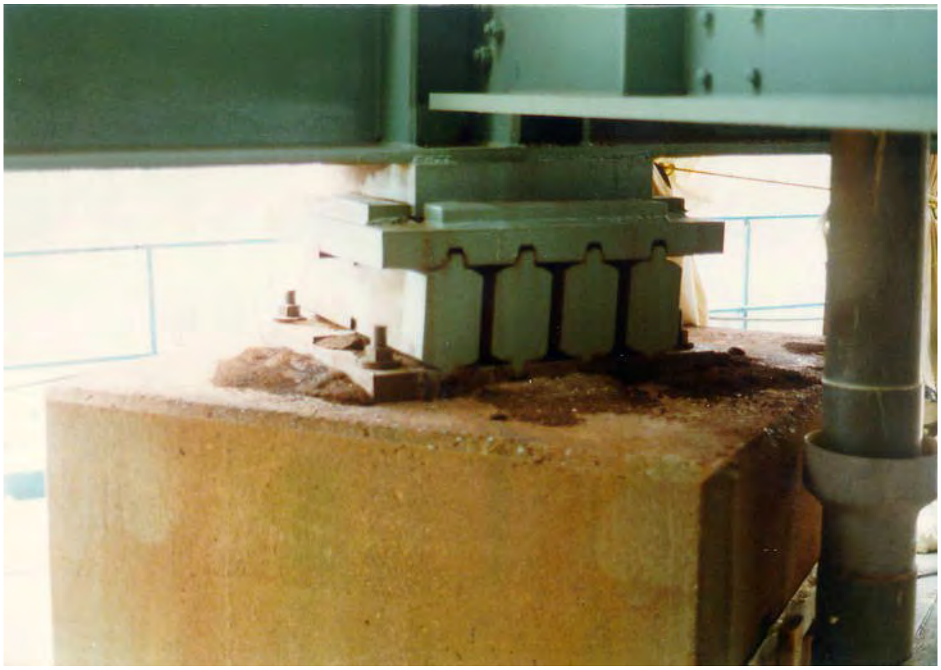


Figure 5.7-12 Nested Rocker Bearing Used for Very Large Spans.

Figure 5.7-13 Elastomeric Bearing. Note the Non-parallel Bearing Surfaces

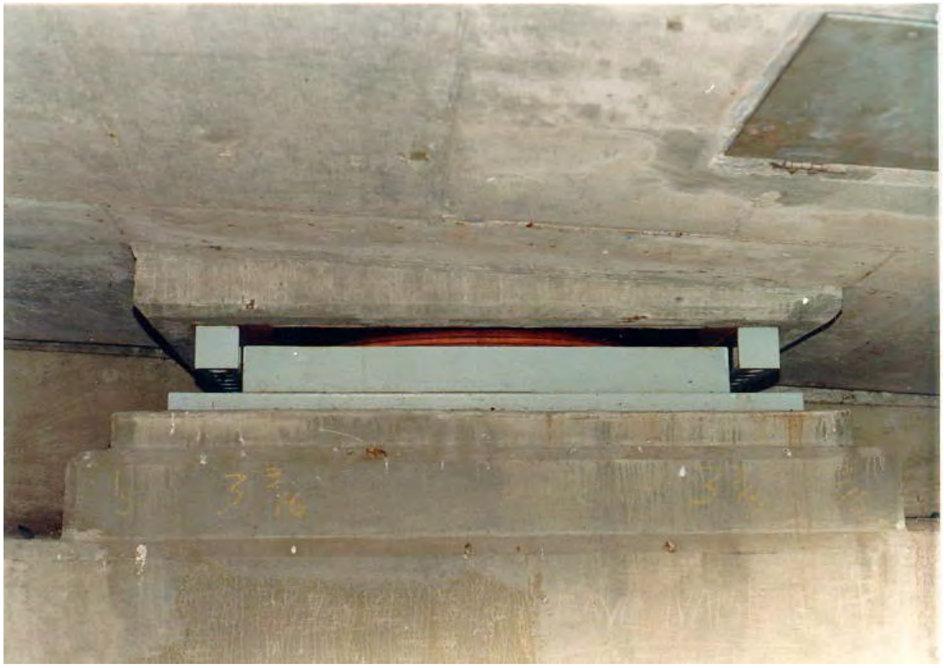


Figure 5.7-14 Pot Bearing with Side Guide Bars

Figure 5.7-15 Center Guided Pot Bearing

5.7.2 Pin and Hanger Assemblies

Reference: BIRM Section 10.1.10, 10.2, 10.3, and 10.4.11

5.7.2.1 Inspection and Documentation Requirements

Initial/Inventory Inspections & Routine Inspections

Inspection

- Inspect the pin and hanger assemblies in accordance with BIRM Sections 10.1.10, 10.2, 10.3, and 10.4.11.
- As stated in Section 4.1.10.1 of this manual, consultants are to be contracted to perform pin and hanger inspections which are required every 48 months.
- All pin and hanger assemblies will be treated as NSTMs, regardless of whether the girders they support are redundant. All pin and hangers will be inspected in accordance with the guidelines established in this section.
- Pin and hanger assemblies will be inspected "hands-on" using adequate lighting to detect corrosion, impacted rust, section loss, hairline cracks (external), impact or collision damage, or other deterioration. This will be done in conjunction with the inspection of the superstructure elements.

> ***Special Note:***
>
> *Pin and hanger assemblies are put in bridges to permit thermal expansion and rotation of the bridge superstructure. If only rotation of the joint is desired, one pin is used to form a hinge in the beam. Where longitudinal expansion is also required, a system consisting of two pins with a hanger between them is used.*
>
> *Hangers are typically designed for pure tension forces. However, hangers may experience both tension and bending. Bending may result from corrosion binding the hanger and preventing rotation. Out-of-plane bending (perpendicular to the wide face) in the hanger bar may result from misalignment or skewed geometry due to transverse forces imparted by impacted rust, improper erection, etc.*
>
> *Pins are normally designed for shear and bearing on the full thickness of the hanger. In pins that have "shoulders" (changes in pin diameter at the threads), the pin can be subjected to excessive bearing stress if the hanger shifts off the pin shoulder and onto the threaded area. Pins can also see very high torsional forces if corrosion inhibits or prevents their ability to rotate freely.*

- Measurements are only required for pin and hanger assemblies that satisfy any of the following: Visual misalignment is observed, or they are part of a 48-month Pin and Hanger inspection. Complete the inspection forms shown in Figures 5.7.2-4 or 5.7.2-5, as they apply.

- Inspect the webs and flanges of the connected beams at all pin and hanger assemblies for proper alignment. This may be checked with a straight edge or plumb bob. Misalignment may indicate lateral movement caused by impacted rust.
- Inspect pin and hanger components for evidence that deck drainage is entering the assembly.
- Inspect the backside of hangers to the extent possible utilizing lights and inspection mirrors for impacted rust. It may be helpful to probe with a wire or slender steel ruler.
- Visually inspect the pin to the extent that it is visible and tap the pin with a hammer to check for significant looseness of the pin, nut and/or retainer cap. Measure the amount of any negative thread noted on each pin nut (the amount that the pin is recessed into the nut). Check the retainer cap to see if it is bent or deformed in any way. Verify that the face of the cap is flat with a straight edge. Verify that the nuts that hold retainer caps in place are tight and that a cotter pin or tack weld between the pin and nut are present and not bent or broken.
- Inspect components for signs of rotation that may be evidenced by cracked and/or worn paint between the hanger and web plates of the connected members. Differential movement between the hanger and web plates will also be noted during live load passage.
- When defects or deteriorations are found in a particular location on a pin and hanger assembly, all other pin and hanger assemblies will be inspected for the presence of similar defects.

Special Note:

If differential movement around the pin and hangers is excessive or if there is notable vertical movement with live load passage, the pins or pin holes may be excessively worn.

- Inspect all rotating components for signs of movement and wear at the interface with other components. This may be evidenced by the presence of red or orange abrasion dust ("bleeding" rust).
- Inspect the hangers closely for signs of fatigue cracking. The critical areas most likely to develop cracks are outlined below and shown in Figure 5.7.2-1:
  - at welds used to connect hanger plates.
  - at welds used to connect web doubler plates.
  - in the base metal at the ends of hangers adjacent to pin holes.
  - in the base metal at the juncture between heads and shanks of eyebars.

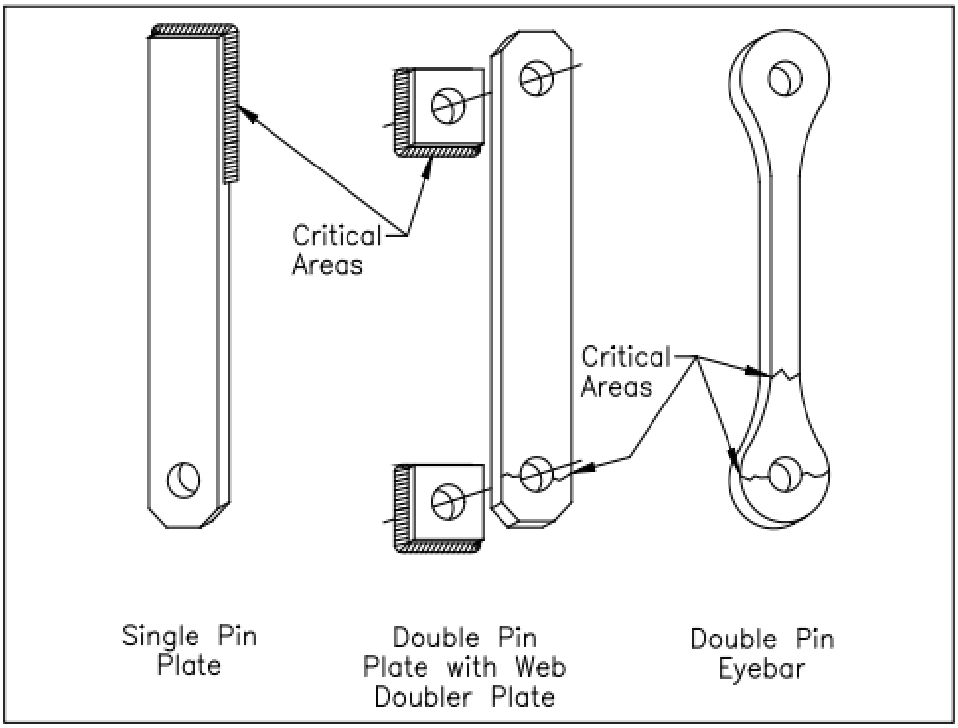


Figure 5.7-16 Fatigue Cracks in Pin and Hanger Assemblies

- All suspected cracks will undergo Nondestructive Testing (NDT) to attempt to confirm the existence and extent of the crack. All confirmed fatigue cracks will immediately be reported in accordance with the Critical Deficiency Reporting/Emergency Response procedures outlined in Section 5.2.
- Inspect retrofit systems, such as supplemental hangers, saddles or "catcher's mitts", for missing components, corrosion, section loss, cracks, and other deterioration. These "back-up" systems are normally designed to catch and support the beam in the event of a hanger failure. Measure the gap between the beams and the retrofit detail. Note if the gap appears too large (excessive impact loads would be applied at failure) or too small (joint movement is restricted). Compare measured gap values with design values. If a neoprene bearing pad is included in the assembly to lessen impact, evaluate the condition and integrity of the pad. Evaluate the ability of the retrofit to function in its design capacity.

Special Note:

Disassembly of Pin and Hanger assemblies for inspection:

- *No portion of any pin and hanger assembly should ever be disassembled by bridge inspection personnel. Partial or total disassembly of a pin and hanger joint should be undertaken only by approved personnel after proper engineering design is performed with auxiliary support supplied.*
- *Removal of the retainer nuts or caps should not be attempted unless an alternate means of retaining the hanger on the pin is in place.*
- *Hangers and pins are generally difficult to remove even after the retaining assemblies are taken off. This is not always true, however, and a pin that is subjected to high torsional stresses due to impacted rust can rotate or fail suddenly if the nut is loosened. Hangers that are subjected to bending stress due to impacted rust may slip off the "shoulder" or pin itself once the nut is loosened.*
- *Partial or full disassembly of pin and hanger assemblies should never be undertaken until all live load is removed from the structure. Live load should remain off the structure until reassembly is complete.*

Nondestructive Testing:

- *Ultrasonic testing is currently the best means available for checking pins in place for internal flaws. However, the presence of "dead spaces" within the pin (locations where sound waves cannot reach due to the geometry of the pin surface relative to the transducer) may skew test results.*
- *Only trained, certified technicians, knowledgeable in the theory and limitations of ultrasonic testing should perform and evaluate the test results.*

- Inspect seated beam assemblies and spliced beam type retrofit details using the inspection guidelines established in Sections 5.7.1 Bearings, 5.7.8 Steel Multi-Girders or 5.7.9 Steel Girder and Floorbeam Systems.

Documentation

- The pin and hanger measurement forms shown in Figures 5.7.2-4 & 5.7.2-5 will be completed for hangers and hinges, where required.
- Document the presence of all loose, missing or cracked components or cracked welds on the pin and hanger assemblies. Mark these locations on the bridge in the vicinity of the assembly with a permanent marker or lumber crayon in such a manner that subsequent inspections may find the locations easily.
- Document all steel losses by noting the area and depth of the loss as well as its relative location on the pin and hanger assembly. Whenever possible, calipers or other measuring devices will be used to measure the remaining section where deteriorations are noted instead of estimating loss.
- Document whether evidence of rotation within the pin and hanger assembly was observed.
- Document the location and amount of any impacted rust found and whether rotation of the hanger assembly is affected.
- Specific care will be given to documenting the current condition of all previously noted deteriorations so the rate of deterioration can be established. If increased quantity or size of

deteriorations causes the condition rating to change from the last inspection, a photograph and explanation of why the rating has changed will be included in the inspection report.

- Note the existence of all leakage or drainage onto the pin and hangers.
- Significant changes in condition state or discovery of critical findings will be documented and reported in accordance with Section 9.3.3 and Section 5.2 of this manual.
- Nonredundant Steel Tension Member Inspections
- “Hands-on” inspection of all NSTM members on the bridge with the use of visual inspection methods where the inspector is about 24” from the surface. In some cases, supplemental non-destructive inspections may be necessary.
- Use additional light and magnification to evaluate the member if necessary.
- Per the NBIS, Nonredundant Steel Tension Member Inspections are to be performed at regular intervals, not exceeding 24 months.
    - However, certain NSTM conditions may require an inspection frequency less than 24 months.
- The Inspection procedure will contain sketches and drawings where needed and fatigue sensitive details will be indicated for NSTM members.
- Record the type, size, and location of any defect.
- If defect is a crack, determine the length and depth (non-destructive testing may be required). Also measure and record the crack width.
- Identify any additional information that may help determine the age and severity of the defect.
- All exposed surfaces of all pin and hanger details and all exposed primary member surfaces within 3 ft of pin and hanger details will receive a 100% close-up, "hands-on" visual inspection during each inspection. This will be done regardless of redundancy.

Damage Inspections

- Inspection methods will vary depending on the type and severity of damage. Damage caused by impact with vehicular traffic will be inspected for signs of misalignment, cracking and loose connections.
- The damage inspection will be coordinated between the inspector, bridge owner, and any other relevant agencies to determine the scope of damage and planned inspection methods.

Documentation

- The inspection report will include but not be limited to thorough documentation of the condition of any Pin and Hanger element that has been damaged. Photographs of the damaged areas are required, and sketches are encouraged if text alone cannot easily convey the scope of the damage.
- As stated in Section 4.1.6 of this manual, damage inspections are typically used in the decision-making process for implementing or lifting emergency load posting restrictions or bridge closures.

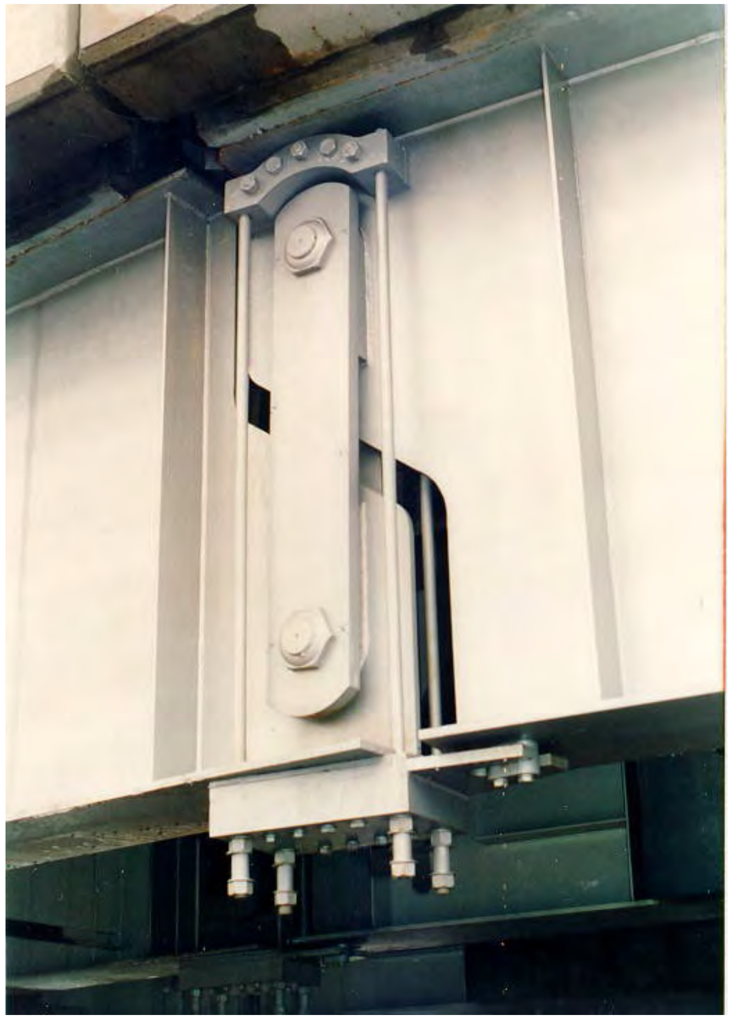


Figure 5.7-17 Expansion Hanger with Sling Backup System Installed.

Documentation

- All documentation required for routine inspections will be included in the detailed documentation plus the results of all ultrasonic testing performed.
- Documentation will clearly describe the structural condition and serve as an accurate benchmark to which future inspections can be compared.
- A good quality photograph, that documents the overall condition of the pin and hanger assemblies as well as detail photographs that support the condition rating, will be provided. All fatigue cracks noted will be photographed.

Figure 5.7-18 New Stainless-Steel Pin and Hanger with “Catchers Mitt” Retrofit Support Beam Installed.

5.7.2.2 Report Review

- Review the inspection findings in accordance with established Quality Control and Quality Assurance procedures.
- The inspection report reviewer will determine if the pattern, quantity, and severity of the deteriorations found support the numerical condition rating given. The reviewer will compare the present inspection report to past reports.
- The inspection reviewer will determine if fatigue problems have been noted on the pin and hanger assemblies and whether patterns of deterioration or progressive deterioration are taking place. Progression will be determined by comparing past and present inspection reports.

5.7.2.3 Maintenance Considerations

- Remove debris and impacted rust to the extent possible without disassembly. Paint or spot paint the pin and hanger assemblies as required to cover exposed steel.
- Ensure that retainer cap nuts are tight and that anti-loosening devices such as cotter pin, tack welds, double nuts, etc., are in place and functioning as designed.
- Perform maintenance on the drainage system to prevent leakage onto the pin and hanger assemblies.

If load has been transferred to the backup system, the performance of the backup system will be reviewed and returning the load to the primary system will be considered.

PIN & HANGER DATA SHEET

Measurements Taken By: ____________ Date: ____________

Bridge No.: ______ ____________________ Town: ____________

Hanger Location: ____________________ Effective span for Movement: ______ (ft) Page: ______ of ______

Beam No.	V (in)	J (in)	T_r (in)	B_r (in)	T_ℓ (in)	B_ℓ (in)	Out to Out (in)	Secondary System Type	Gap[1] (Y/N)	Nut Restraint System	Temp	**Comments**
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												

Notes:

1) For Pin & Hanger assemblies with a redundant support system, indicate if there is a gap between the redundant system (bearing) and the bottom flange of the suspended girder.
2) All measurements are taken in reference to log direction.
   - **V** : Vertical misalignment of girders @ left edge of girder's bottom flange.
   - **J** : Joint opening between webs, measured just above the bottom flange fillet, on the left face of the girder's web.
   - **Out to Out :** The out-to-out of hangers taken at the leading edge, based on log direction.
3) Use a permanent marker to indicate locations of field measurements.

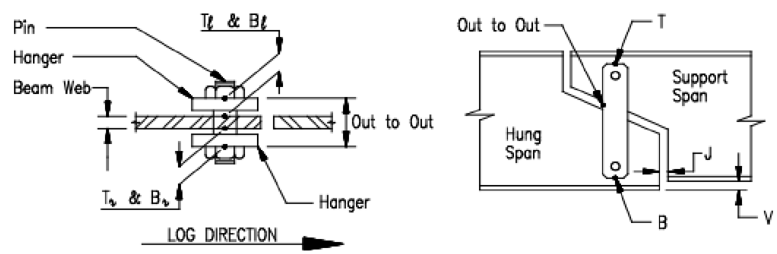


Figure 5.7-19 Expansion Hanger Measurement Form

HINGE DATA SHEET

Measurements Taken By: ______ Date: ______

Bridge No.: ______ ______ Town: ______ ______ Date: ______

Hinge Located: ______ Effective span for Movement: ______ (ft) Page: ______ of ______

Beam No.	V (in)	J (in)	R (in)	L (in)	Secondary System Type	Gap[1] (Y/N)	Nut Restraint System	**Comments**
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

Notes:

1) For Hinge assemblies with a redundant support system, indicate if there is a gap between the redundant system (bearing) and the bottom flange of the suspended girder.
2) All measurements are taken in reference to log direction.
   - **V** : Vertical misalignment of girders @ left edge of girder's bottom flange.
   - **J** : Joint opening between webs, measured just above the bottom flange fillet, on the left face of the girder's web.
3) Use a permanent marker to indicate locations of field measurements.

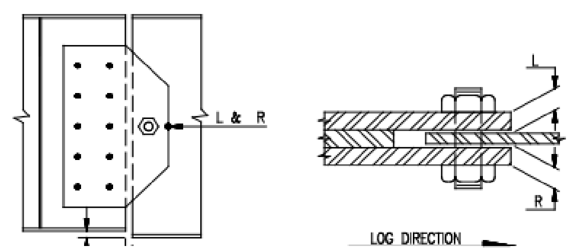


Figure 5.7-20 Hinge (Fixed Hanger) Measurement Form

5.7.3 Reinforced Concrete Slabs

Reference: BIRM Sections 9.1.2, 9.2, 9.3 and 9.4

This section describes the inspection requirements for reinforced concrete slab superstructures. The requirements for concrete decks are discussed in Section 5.6.2. A concrete slab superstructure is a slab that is supported directly by the substructure. This type of superstructure is also known as an "Integral Deck" superstructure because the superstructure is also the riding surface or "deck."

5.7.3.1 Inspection and Documentation Requirements

Initial/Inventory Inspections & Routine Inspections

Inspection

- Inspect the slab in accordance with BIRM Section 9.1.2.
- The underside of the slab will be viewed from a distance close enough and with adequate lighting to detect cracks 0.012" wide.
- All areas of suspected delamination and at least 25% of those areas on the bottom of the slab showing cracking, scaling, wetness or staining will be tapped with a hammer or metal rod to determine soundness. For top of slab, reference Concrete Decks Section 5.6.2 requirements.

Documentation

- The size and location of cracks, spalls, delaminations, etc., will be noted. Where these cannot be described narratively, a sketch of the slab underside will be made that shows the size, location and orientation of deficiencies found. Cracks with rust staining will be documented as such since they may be indicative of leakage through the slab and deterioration of the reinforcing steel. Spalls that expose reinforcing steel will be specifically noted and include any deterioration or section loss on the exposed steel.
- Specific care will be paid to document increased quantity or size of deteriorations that have changed since the last inspection. If the condition rating has changed from the last inspection (up or down), a photograph or explanation of why the rating has changed will be included.
- Notes will be made describing the current condition of any previously discovered item that was being monitored.
- Significant changes in condition state or discovery of critical findings will be documented and reported in accordance with Section 9.3.3 and Section 5.2 of this manual.

Damage Inspections

Inspection

- Inspection methods will vary depending on the type and severity of damage. Damage caused from vehicle live loads, such as spalling and damaged reinforcement, may require only a visual examination at one location.
- The damage inspection will be coordinated between the inspector, bridge owner, and any other relevant agencies to determine the scope of damage and planned inspection methods.

Documentation

- Included, but not limited to, in the inspection report will be thorough documentation of the condition of any slab element that has been damaged. Photographs of the damaged areas are required, and sketches are encouraged if text alone cannot easily convey the scope of the damage.

- As stated in Section 4.1.6 of this manual, damage inspections are typically used in the decision-making process for implementing or lifting emergency load posting restrictions or bridge closures.

5.7.3.2 Report Review

- Review the inspection findings in accordance with established Quality Control and Quality Assurance procedures.
- The inspection report reviewer will determine if the pattern, quantity, and severity of the deteriorations found support the numerical condition rating given. The reviewer will compare the present inspection report to past reports.
- The sudden or progressive appearance of flexure or shear cracks may indicate the need for a new structural evaluation and/or posting of the bridge structure for a weight restriction.
- Low condition ratings, which are caused by extensive widespread deterioration, could be reason to request supplemental testing to better determine the condition of the slab and whether rehabilitation or replacement is warranted.

5.7.3.3 Maintenance Considerations

- Due to the difficulty inherent with overhead concrete patching and the non-structural nature of the bottom surface concrete in typical simple span slabs, repair of spalled areas on the undersides of slabs is not normally necessary, except in slab bearing areas. At most locations, loose or hollow concrete will be removed, and the spalled area cleaned and coated with an appropriate material that will protect exposed reinforcing steel and prevent further deterioration.
- For the top of slab, reference Concrete Deck Section 5.6.2 for maintenance considerations.
- Waterproofing methods can be the best way to prevent or slow the deterioration of reinforced concrete members. Care must be taken in the application of waterproofing systems to ensure that they are not applied in such a way as to prevent existing moisture in the slab from exiting.

Figure 5.7-21 Typical Concrete Slab Bridge

Important Note for upcoming Sections 5.7.4, 5.7.7 and 5.7.8: *For manual sections 5.7.4, 5.7.7 and 5.7.8, a different format is being applied for use and feedback from inspectors, prior to applying to all of Sections 5.6 through 5.8 for Deck, Superstructure and Substructure. This procedure is described below:*

There are general inspection procedural requirements which apply to all types of bridges and elements for biennial/routine inspections. General procedural requirements which apply to all Damage Inspections, Follow-up Inspections, Report Review and Maintenance Considerations are also covered below. In addition to procedural requirements, there are other inspection procedures that may be performed at the discretion of the inspector, referred to as “Inspector Judgment” procedures.

In the above noted sections, procedures are bulletized using either an “**R**” indicating “**Required**” or an “**I.J.**” indicating item is to be followed based on the “**Inspector’s Judgement**”, as they may apply in some situations, but not others. Inspector Judgment procedures may not be used if their use results in a significant increase in the level of effort for little gain or if such procedures cause inspecting, documenting or reporting beyond what is necessary.

The process for using these sections:

1. Follow the General procedures below.
2. Follow the procedures for the type of inspection you are performing (e.g., Damage, Follow-up, etc.) below.
3. Follow the procedures for the type of materials and bridge components you are inspecting (i.e., concrete superstructures, timber substructures, etc.) below.
4. Follow procedures in the specific Section(s) which apply to the type of bridge you are inspecting (e.g., Section 5.7.4 Concrete Reinforced T-Beams, Section 5.8.3 Timber Substructures, etc.).

General Inspection Procedures

- **R** Inspection methods must be sufficient to determine and document the type, quantity, location, and extent of defects listed in the MBEI condition state tables and MDT’s ADE tables in Chapter 8. Field notes must be sufficient to be able to differentiate and divide the defect quantities among the four condition states for every element.
- **R** Inspection methods will consist of a progression, starting with visual, followed by physical for areas with visual defects requiring hands-on access to properly condition code (e.g., hammering suspect delamination or measuring section loss to steel). Advanced inspection methods may be required to properly condition code certain defects (i.e., using UT to confirm extent of fatigue cracks).
- **R** If the NBI condition rating has changed from the previous inspection due to increased quantity, size or severity of deterioration, the inspection report will include photographs and/or documentation to justify why the rating has changed.
- **R** Defects that may directly affect a structure’s load rating will be documented with enough accuracy to be used to update the load rating without the need for a separate field visit. Defects will include the defect dimensions, as well as a location from a fixed point on the bridge. Where these defects cannot be described using text, a sketch of the framing plan will be made that shows the size, location and orientation of deficiencies found.
- **R** Critical Findings will be documented and reported in accordance with Section 5.2 of this manual.

- I.J. Relevant sections of the FHWA BIRM will provide “best-practice” information will be used to guide inspection and documentation.

Damage Inspection Procedures:

Inspection

- R Coordinate the damage inspection between the inspector, bridge owner, and any other relevant agencies to determine the extent of damage and planned inspection methods.

- I.J. Inspection methods will vary depending on the type and severity of damage. Timber deck elements that have been damaged by fire may require a widespread visual and physical examination including the removal of charred surfaces, sounding, and probing. Damage caused from vehicle live loads, such as spalling and damaged reinforcement, may only require a visual examination at one location.

Documentation

- R Include thorough documentation of the condition of any primary element that has been damaged. Photographs of the damaged areas are required.
- R Sketches are required only when text cannot convey the nature and extent of the damage.

Follow-up Inspection Procedures:
Inspection & Documentation

- R Inspection and documentation methods will be the same as the methods that were used or intended to be used when the inspection was first performed or intended to be performed.

Report Review Procedures:

- R Review the inspection findings in accordance with established Quality Control and Quality Assurance procedures in Chapter 10.

- I.J. Low condition ratings that are caused by extensive or widespread deterioration are possible reasons to suggest supplemental testing to better determine the condition of the element and whether rehabilitation or replacement is warranted.
- I.J. Suggest load rating updates due to conditions found at the structure (timber decay, section loss to steel members, structural cracking in concrete members, etc.).

Maintenance Consideration Procedures

- R Follow guidance in Section 9.3.3 for documentation/generation of Repair Suggestions. In addition, specific example or repair suggests are given in each section of this chapter for the various bridge materials/components. Repair Suggestions will be input into BrM in the Work Candidates tab. Note that this tab has numerous input fields with dropdown menus to assist the inspector that must be filled out.

- I.J. Clean debris such as sand, spider webs, bird nests which obscure and inhibit proper inspection of element surfaces. A Repair Suggestion may be required if debris removal is extensive, time consuming, or hazardous.

Procedures for Concrete Superstructures: Initial/Inventory Inspections and Routine Inspection

Inspection

- R Look at bearing areas for spalling and crushing due to friction from thermal movement and high bearing pressure.
- R Look at areas near the supports for the presence of diagonal (shear) cracks. These will occur on the side of the stem or web and project up from the supports toward midspan.
- R Look at tension zones for flexure cracks (which are due to overload in bending) and would be perpendicular to the member. Also look to deteriorated concrete (delaminations, spalls, and cracks with efflorescence, etc.), which could cause or be evidence of debonding of the tension reinforcement.
- R Look at areas exposed to drainage for concrete spalling and scaling. This may be particularly evident along the curbline, at curb drains, scuppers or other thru-deck drains, and at the ends of beams where drainage seeps through deck joints.
- R Look for repaired areas to determine if repair materials are in place and functioning as designed.
- I.J. Hammer-tap patched areas to determine if the patch is sound and adhering to the base material.

Documentation

- R Document the size and location of defects including cracks, spalls, delaminations, etc.

Procedures for Steel Superstructures: Initial/Inventory Inspections and Routine Inspection

- R The entire superstructure will be inspected with emphasis on areas of maximum moment (midspan for simple span beams and the area over the piers for continuous beams), ends of cover plates (or other locations of abrupt change in member cross section), bearing areas, connection plates and diaphragm connections.
- R Sight along the flanges of beams for evidence of compression flange buckling or dead load deflection ("negative camber").
- R Bolts and rivets will be visually inspected for tightness and section loss. Broken paint or bleeding rust around a bolt or rivet may indicate a loose or broken fastener.
- R All visually suspected cracks on primary members will be inspected hands-on.
- R The extent of identified cracks in primary members will be recommended for advanced Nondestructive Testing (NDT) to confirm their existence and to determine the extent of crack.
- R All pin and hanger details will be inspected in accordance with Section 5.7.2.
- I.J. Laminated rust will be removed from high stress areas (flanges at midspans for simple spans and over supports for continuous spans and also webs near supports) to measure section losses.
- I.J. Girder/beam webs will be checked for signs of web crippling (out-of-plane bending) or beam tipping at all support locations.
- I.J. Twenty-five percent (25%) of all cover plate ends will be inspected "hands-on" during each routine inspection. It will be clearly indicated in the inspection report, which beam cover plates were inspected "hands-on." A different 25% will be inspected on each subsequent inspection. This provides for a "hands-on" inspection of all the cover plate ends every four routine inspection cycles.

I.J. Suspect fasteners will be tapped with a hammer to confirm their integrity.

I.J. When defects are found in a particular detail or location on a member, all other similar details or member locations will be inspected for similar defects.

I.J. Welded repairs, diaphragm or utility connections, and any miscellaneous welds in the tension zones of beams will be inspected closely for fatigue cracks or other defects.

Some Pointers to Remember

About Weld Inspection

- *Visual inspection tells most. However, locations of ends of cracks may be erroneous as sub-surface crack propagation may be more extensive than surface propagation.*
- *Magnetic-particle inspection is outstanding for detecting surface or near-surface cracks and is used to advantage on heavy weldments and assemblies.*
- *Dye-penetrant is easy to use in detecting surface cracks. Its indicators are readily interpreted.*
- *Ultrasonic inspection is excellent for detecting subsurface discontinuities but requires expert interpretation and certification.*

Documentation

R Document the extent and severity of all rusting. Significant loss, whether from past or current rusting will be noted in sufficient detail for a load rating analysis to be performed. Engineering judgement is required in the field to determine the significance of areas with loss, but as a guideline specific notes are required when:

a) Greater than 15% of the flange area is lost in areas of high moment.

b) Greater than 30% of the web area is lost in areas of high shear.

c) Less significant losses (typically <1/8”) will be noted, but exact measurements are not required.

R Document steel losses by noting the area and depth of the loss as well as its relative location along the length of the beam measured from a fixed point (e.g., 12” H x 12” W x 1/8” deep loss on girder web at the bottom flange, beginning 3’ from the west bearing on girder G1).

R Document locations and lengths of all cracks found on primary members. Mark these locations on the bridge with permanent marker or lumber crayon. Note the date found and the limit of crack propagation in such a manner that subsequent inspections may determine additional crack propagation. If any retrofit has been made to an old crack or holes drilled to arrest existing cracks, document whether the crack has propagated past the arresting hole.

- I.J. Whenever possible, where deterioration is noted, calipers, D-Meter or other measuring devices will be used to measure the remaining section instead of estimating the loss. Notes will clearly indicate whether an "estimated loss" or measured remaining thickness is being given.
- I.J. Document locations and condition of all welded repairs or connections and other miscellaneous welds in the tension zones of the beams, if they were not detailed on the construction plans or noted in previous inspections.
- I.J. Document repaired locations and the details of the repairs (size, location, connection, etc.).
- I.J. Document in the field notes, the locations of loose bolts/rivets.

5.7.4 Reinforced Concrete T-Beams

Reference: BIRM Sections 9.1.3, 9.2, 9.3, and 9.4

This type of superstructure is also known as an "Integral Deck" superstructure because the top flange/slab portion of the superstructure is also the riding surface or "deck."

5.7.4.1 Inspection and Documentation Requirements

Initial/Inventory Inspections & Routine Inspections

Inspection

- I.J. Inspect the superstructure in accordance with BIRM Sections 9.1.3, 9.2, 9.3, and 9.4.
- I.J. Sound with a hammer or metal rod all areas of suspected delamination and at least 25% of those areas showing cracking, scaling, wetness, staining or other deterioration to determine soundness and/or extent of deterioration.

Figure 5.7-22 Concrete T-Beams with Large Spalls Exposing the Bottom Layer of Reinforcing Steel

5.7.4.2 Maintenance Considerations

- I.J. Due to the difficulty inherent with overhead concrete patching, and the non-structural nature of bottom surface concrete in typical simple span T-beams, repair of minor spalled areas on the bottom of the T-beam stem or top flange is normally not necessary. At most locations, loose or hollow concrete, which does not extend beyond the depth of the bottom layer of reinforcement, will be removed and the spalled areas cleaned and coated with an approved material that will protect any exposed reinforcing steel and prevent further deterioration. However, if the spall is deeper than the bottom layer of reinforcing steel, patching operations will be conducted.

I.J. Waterproofing methods can be the best way to prevent or slow the deterioration of reinforced concrete members. However, care must be taken in the application of waterproofing systems to ensure they are not applied in such a way as to prevent existing moisture in the T-beams from exiting.

5.7.5 Concrete Rigid Frames and Closed Spandrel Arches

Reference: BIRM Sections 9.1.6, 9.1.7, 9.2, 9.3 and 9.4

5.7.5.1 Inspection and Documentation Requirements

Initial/Inventory Inspections & Routine Inspections

Inspection

- Inspect the concrete rigid frame or closed spandrel arch in accordance with BIRM Sections 9.1.6, 9.1.7, 9.2, 9.3 and 9.4.
- The entire superstructure will be inspected from a distance close enough and with adequate lighting to detect cracks 0.012” wide, as well as scaling, spalling, exposed reinforcing (with or without corrosion loss), delamination, impact damage or other defects.
- Suspect areas will be inspected "hands-on" to determine the type and extent of deterioration or deficiency.
- Inspect the area of the arch ring/skew back interface for deterioration.
- Inspect the arch or frame intrados (underside surface) for longitudinal cracks that may indicate differential vertical movement across the transverse section. Look for transverse tension cracks near the crown that may indicate an overload/overstress condition.
- Inspect the arch ring/spandrel wall interface for cracks and spalls that may indicate deflection of the wall or differential movement of the arch ring.
- Inspect the spandrel walls for bulging, tilting, or other signs of deterioration and signs of fill material exfiltration.
- Inspect the top of the roadway for signs of cracking parallel to the centerline of the arch, pavement pull-away from curb lines or for depressed pavement. Depressions or signs that the pavement has been patched may indicate loss of fill material or rotation of the spandrel walls.

Special Note:

In closed spandrel arch structures that are earth filled, the spandrel walls are primary members. They act as retaining walls and serve to resist the lateral earth pressures that develop in the fill material during transfer of dead and live loads to the arch ring. Cracks and spalls, which are large enough to allow exfiltration of fill material, reduce the effective transfer of load and can cause voids to develop below the roadway pavement. They will be sealed to prevent further exfiltration and monitored for recurrence.

Because asphalt pavements and/or fill material are porous, water can easily penetrate to the inside surfaces of arch rings, spandrel walls and frame legs. If weepholes are ineffective and water is retained, unintended water pressure and/or deterioration may take place on the inside face long before water seepage, staining, or other signs of deterioration are noticeable on the outside face. Once cracks or spalls penetrate to the outside surface, water can accelerate exfiltration of fill material.

- Check all areas exposed to drainage for concrete spalling and scaling. This may be particularly evident below the roadway curbline, and around scuppers and weepholes.
- Check that scuppers are not clogged, and that surface water drains away properly so that it does not saturate the fill material and/or penetrate to the structural concrete.
- Check weepholes to see if they appear clear to permit proper drainage of the backfill.
- Check for shear cracks that initiate at the intersection of the frame leg and intrados (underside surface) and propagate upward into the frame slab toward midspan or downward into the leg.
- Check the tension zones in frames for flexure cracks, cracks with rust stains or efflorescence, exposed or corroded tensile reinforcement, or deteriorated concrete that could cause debonding of the tension reinforcement.
- Check the frame legs for horizontal cracks that could indicate excessive backfill pressure, and for loss of section due to spalling or scaling that would increase the compressive stresses. Check for exposed reinforcement.
- Investigate areas that have been damaged due to impact for concrete damage (compression zones) and reinforcement damage (tensile zones).
- Inspect repaired areas to determine if repair materials are in place and functioning as designed. Hammer-tap patched areas to determine if the patch is sound and adhering to the base material.
- Look for spalling, scaling or delaminated concrete that is located above roadway travel lanes and could cause problems if it were to become loose and drop to the roadway below.

Documentation

- Document deficiencies and deteriorations observed. Dimensions will include the length, width, height, depth of loss, orientation, and location relative to a fixed point.
- Elevation and plan drawings may be provided to show the layout of the arch ring, frame, spandrel walls and foundation, along with all noted deteriorations. If required, additional sectional views and detail drawings will be provided as necessary to adequately describe the extent of deficiencies noted. Sketches will be provided if significant deterioration is found.
- Notes will be made describing the current condition of all previously noted problems so that a rate of deterioration can be established for monitoring purposes. If a condition rating has changed from the previous inspection due to increased quantity or size of deterioration, or if the deterioration has been repaired, photographs, documentation, and an explanation of why the condition rating has changed will accompany the report.

- Significant changes in condition state or discovery of critical findings will be documented and reported in accordance with Section 5.2 of this manual.

5.7.5.2 Report Review

- Review the inspection findings in accordance with established Quality Control and Quality Assurance procedures.
- The inspection report reviewer will determine if the pattern, quantity, and severity of the deteriorations found support the numerical condition rating given. The reviewer will compare the present inspection report to past reports.
- Transverse cracking in the arch ring may indicate possible differential deflection of the arch ring and can seriously affect the ability of the arch ring to carry load. If these cracks are noted, further investigation as to the cause and effects will be considered.
- Rigid frames rely on the integrity of the moment connection between the slab and leg to transfer dead and live load moments to the footings. Cracking, spalling, exposed rebar, or other deterioration noted in this area, particularly in the tension area, will be monitored closely and further investigation as to the cause and effects will be considered.

5.7.5.3 Maintenance Considerations

- Spalls noted during the inspection will be patched utilizing approved materials and details. If exposed reinforcing bars are present, they will be cleaned of all rust and coated with an approved protective coating prior to patching operations. Consideration will be given to replacing severely corroded sections of reinforcing bars and/or utilizing wire mesh to reinforce the patch.
- Weepholes and scuppers will be cleaned as needed to ensure proper drainage.
- Debris buildup on the roadway will be removed as needed to allow water runoff to drain effectively.
- Potholes and/or spalls in the roadway surface will be patched utilizing approved materials and procedures to prevent increased impact stresses and further deterioration.

Figure 5.7-23 Figure 5.7.5-1 A Closed Spandrel Reinforced Concrete Arch Bridge

Figure 5.7-24 Single-span Rectangular Concrete Rigid Frame Bridge

5.7.6 Open Spandrel Concrete Arches

Reference: BIRM Section 9.1.6, 9.2, 9.3 and 9.4

NOTE: The inspection criteria described in this section conservatively assumes that transverse floorbeams act integrally with the spandrel columns to form a rigid frame system. Also, it is assumed that any spandrel beams spanning longitudinally between the spandrel columns create a rigid frame configuration and will be inspected as such. Floorbeams supported on top of the longitudinal spandrel beams will be inspected as a continuous beam with cantilevered ends.

5.7.6.1 Inspection and Documentation Requirements

Initial/Inventory Inspections & Routine Inspections

Inspection

- Inspect the open spandrel concrete arches in accordance with BIRM Section 9.1.6, 9.2, 9.3 and 9.4.
- All superstructure elements will be inspected on all sides and surfaces from a distance close enough and with adequate lighting to detect cracks 0.012" wide, as well as scaling, spalling, exposed reinforcing (with or without corrosion loss), delamination, impact damage or other defects.
- All suspect areas will be inspected "hands-on" to determine the type and extent of deterioration or deficiency.
- Inspect the arch rib/spandrel column interface for horizontal cracks that may indicate excessive bending in the column due to overloads or differential arch rib deflection.
- Inspect the spandrel column/floorbeam interface for diagonal (shear) cracks that begin at the interface corner and propagate upward over the column. These may indicate differential arch rib deflection.
- Inspect the tension zones of floorbeams and spandrel beams for deteriorated concrete that could cause debonding of the tensile reinforcement.
- Inspect the area near the floorbeam and spandrel beam supports for the presence of shear cracks. These cracks will appear on the sides of the beams and project upward toward the beams midspan.

- Tension areas of floorbeams and spandrel beams will be inspected for the presence of flexure cracks. These cracks will appear at the bottom of the floorbeam near midspan. In the case of continuous spandrel beams or cantilevered floorbeams, these cracks may also appear at the top of the beams at the supports.
- When arch ribs are connected with struts, check the arches near the strut connection for diagonal cracks due to torsional shear caused by differential arch rib deflections.
- Inspect the arch ribs for cracks. Longitudinal cracks along the centerline of the rib or transverse cracks may indicate an overstress condition.
- Inspect the arch ribs for any section loss due to spalling that will increase the compressive stresses at the area of loss. Maximum compressive stresses in the arch ribs occur at the connection to the substructure.
- Inspect the spandrel columns for buckling due to eccentric loading. If a column is discovered to be buckled, the arch rib adjacent to the column will be inspected for torsional distortion.
- Examine all floorbeams and spandrel beams at bearing areas for spalling or crushing due to high bearing pressure.
- Examine all cracks for rust stains. This indicates possible rusting of the steel reinforcement that is not visible.
- Check areas exposed to water drainage for concrete spalling, delamination, and scaling. This may be particularly evident along the curblines, at scuppers, and at deck joints.
- Investigate areas that have been damaged due to collision for concrete damage (compressive zones) and reinforcement damage (tension zones).
- Inspect repaired areas to determine if repair materials are in place and functioning as designed. Hammer-tap patched areas to determine if the patch is sound and adhering to the base material.
- Inspect the arch superstructure elements above the floorbeams/bent caps using the procedures outlined in other sections of this manual as applicable.

Documentation

- Document deficiencies and deteriorations observed. Dimensions will include the length, width, height, depth of loss, orientation, and location relative to a fixed point.
- A framing plan of the deck system and an elevation of the arch rib will be provided as needed to show the layout of the superstructure. All notable deteriorations will be located on these sheets. Section views and detail drawings will be provided as necessary to adequately describe the extent of deficiencies noted. Also note that very detailed descriptions and locations of deteriorations are required to avoid confusion as to the exact location
- Notes will be made describing the current condition of all previously noted problems so that a rate of deterioration can be established for monitoring purposes. If a condition rating has changed from the previous inspection due to increased quantity or size of deterioration, or if the deterioration has been repaired, photographs, documentation, and an explanation of why the condition rating has changed will accompany the report.
- Significant changes in condition state or discovery of critical findings will be documented and reported in accordance with Section 5.2 of this manual.

Damage Inspections

Inspection

- Inspection methods will vary depending on the type and severity of damage. Damage caused from vehicle live loads, such as spalling and damaged reinforcement, may require only a visual examination at one location.

- The damage inspection will be coordinated between the inspector, bridge owner, and any other relevant agencies to determine the scope of damage and planned inspection methods.

Documentation

- The inspection report will include, but not be limited to, thorough documentation of the condition of any Arch element that has been damaged. Photographs of the damaged areas are required, and sketches are encouraged if text alone cannot easily convey the scope of the damage.
- As stated in Section 4.1.6 of this manual, damage inspections are typically used in the decision-making process for implementing or lifting emergency load posting restrictions or bridge closures.

5.7.6.2 Report Review

- Review the inspection findings in accordance with established Quality Control and Quality Assurance procedures.
- The inspection report reviewer will determine if the pattern, quantity, and severity of the deteriorations found support the numerical condition rating given. The reviewer will compare the present inspection report to past reports.
- The sudden or progressive appearance of cracks in the tension zones of any arch superstructure members or at any of the interfaces described in this section may indicate the need for a new load analysis and/or weight restriction on the structure.
- Because of the nature of open spandrel arches, with multiple elevation views of individual arch ribs, columns, spandrel beams and floorbeams, it is easy to inadequately document the location of defects. Therefore, the inspection report reviewer will review the field notes to ensure that correct nomenclature is used, and that section and detail sketches are correctly drawn and adequately described.
- It is very unlikely the spandrel columns and arch ribs of the arch superstructure will act in pure compression (as theory would describe) due to eccentric loading of the spandrel columns. Therefore, tensile stresses may develop in the columns and torsional stresses may develop in the arch rib below the column. The reviewer will review the inspection report and field notes for documentation of columns (particularly long columns), that appear to have flexure cracks, and ribs that have torsional cracks. If these cracks are noted, additional investigation as to the cause and effect is warranted.
- Review the inspection report and field notes for evidence of cracking caused by differential deflection of the arch ribs. These cracks are most common at the column/arch rib interface, the column/floorbeam/spandrel beam connection and arch strut/arch rib interface. Signs of arch rib differential deflection will be closely monitored and may warrant further investigation as to the long-term effects on the structure.
- Section loss due to spalls in compression members will cause higher compressive stresses in the member at the location of loss. Review the inspection report and field notes for locations of excessive section loss that may warrant further investigation.

Figure 5.7-25 Open Spandrel Concrete Arch Bridge

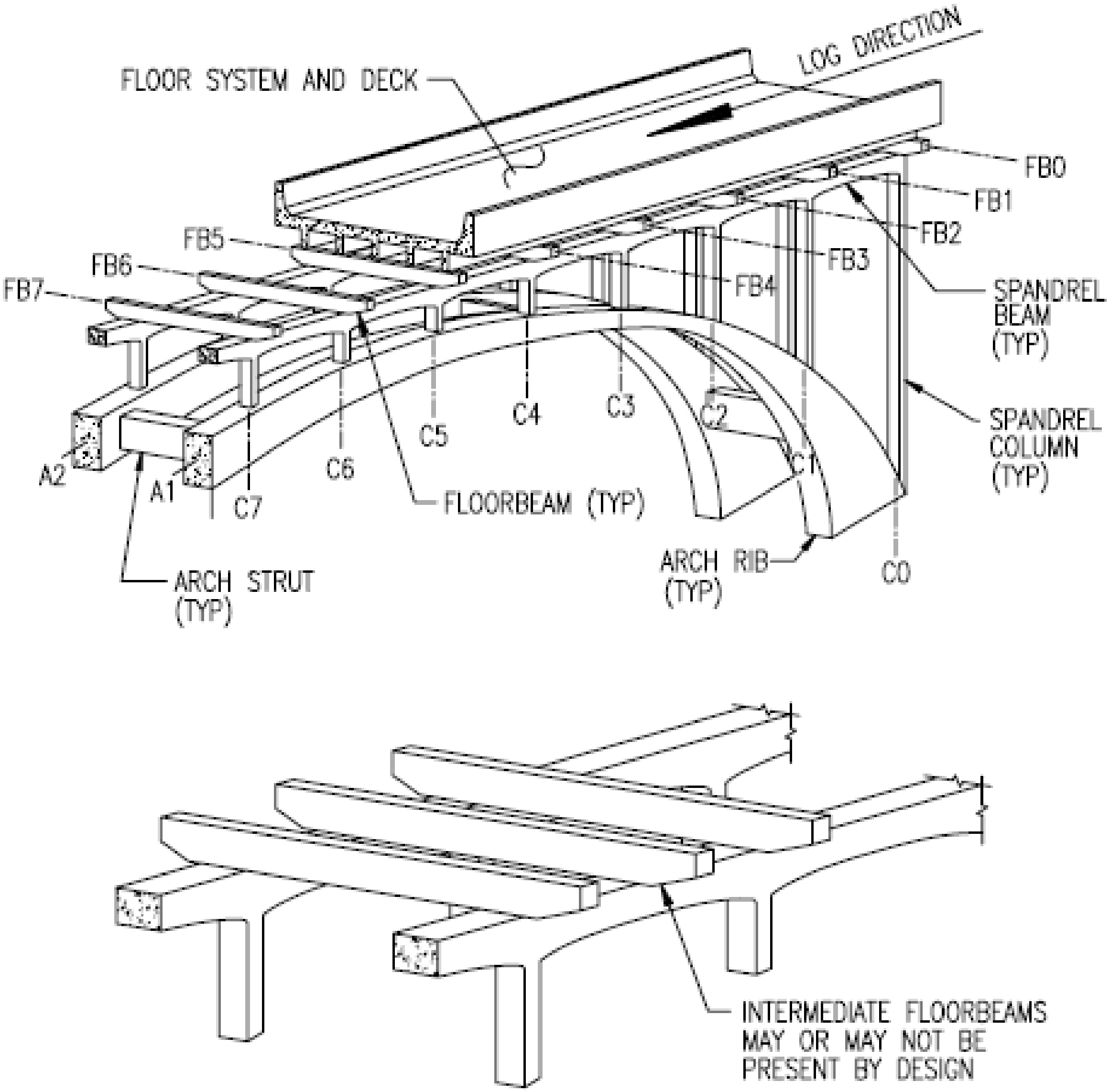


Figure 5.7-26 Open Spandrel Concrete Arch Bridge Components.

5.7.6.3 Maintenance Considerations

- Spalls noted during the inspection will be patched utilizing approved materials and details. If exposed reinforcing bars are present, they will be cleaned of all rust and coated with an approved protective coating prior to patching operations. Consideration will be given to replacing severely corroded sections of reinforcing bars and/or utilizing wire mesh to reinforce the patch.
- Scuppers and deck joints will be cleaned as needed to insure proper drainage.
- Debris buildup on the roadway will be removed as needed to allow runoff to drain effectively.

- Potholes and/or spalls in the roadway surface will be patched utilizing approved materials and procedures to prevent increased impact stresses and further deterioration.
- Certain structural cracks may be repaired using chemical repair techniques. Engineering judgment and discussion are required for specific applications.

5.7.7 Prestressed and Post Tensioned Concrete Superstructures

Reference: BIRM Sections 9.1.8 through 9.1.11, 9.2, 9.3 and 9.4

See "***Important Note for upcoming Sections 5.7.4, 5.7.7 and 5.7.8***": located just before Section 5.7.4 for General, Damage and Follow-up inspection procedures and Report Review, Maintenance Considerations and Concrete Superstructure procedures prior to applying the below specific prestressed and post-tensioned inspection procedures.

5.7.7.1 Inspection and Documentation Requirements

Initial/Inventory Inspections & Routine Inspections

Inspection

I.J. Inspect the superstructure in accordance with BIRM Sections 9.1.8 through 9.1.11, 9.2, 9.3 and 9.4.

I.J. The interiors of box beams/girders will be inspected whenever they are accessible. Documentation/monitoring of deterioration/cracking will be done primarily from the interior of the boxes. Inspection of the interiors of box beams requires additional safety precautions. Refer to the section on inspection of steel box girders for comments on safety.

Documentation

R Flexure and shear cracks larger than 0.004" will be measured and accurately located.

I.J. Nonstructural cracks need not be measured, but their general size, length, direction, location, and quantity will be documented in the inspection report.

5.7.8 Steel Multi-Girders

References: BIRM Section 10.1.2, 10.1.3, 10.2, 10.3 and 10.4

MDT Hands-On Inspection of Steel Members

See "***Important Note for upcoming Sections 5.7.4, 5.7.7 and 5.7.8":*** located just before Section 5.7.4 for General, Damage and Follow-up inspection procedures and Report Review, Maintenance Considerations and Steel Superstructure procedures prior to applying the below specific steel multi-girder inspection procedures.

5.7.8.1 Inspection and Documentation Requirements

Initial/Inventory Inspections & Routine Inspections

Inspection

I.J. Inspect the superstructure in accordance with BIRM Section 10.1.2, 10.1.3, 10.2, 10.3 and 10.4.

5.7.8.2 Report Review

I.J. The appearance of new or sudden propagation of existing cracks may warrant a new load rating or fatigue analysis, and/or posting of the bridge structure for a weight restriction.

5.7.8.3 Maintenance Considerations

I.J. Fatigue cracks, that show little or no crack propagation for extended periods, can suddenly resume propagation, possibly resulting in member failure. Therefore, all cracks found on primary members will be immediately reported and corrective action will be taken as soon as possible to ensure the integrity of the structure and safety of the public.

I.J. Areas of severe rusting will be cleaned and coated to prevent further deterioration.

Figure 5.7-27 Typical Rolled Multi-Stringer Superstructure with Ends of Partial Length Welded Cover Plates Visible.

5.7.8.4 Steps to Follow When Fatigue Cracks are Observed

Fatigue cracks are most detrimental to the safety and performance of a structure or component when they are orientated in a direction perpendicular to the applied stress. If a crack is detected, the following steps are recommended:

In the field:

1. A sketch and photographs will be prepared so that the crack location, size, and orientation can be evaluated.
2. Determine the locations of the ends of the crack visually. The crack tip will, in general, extend beyond the crack in the paint film and beyond any oxide indication.
3. Examine any other identical details on the bridge. Additional fatigue cracks are likely to occur at any time in similar details at the same relative location within the detail. Those details attached to members located under the most heavily traveled truck lanes will be examined first in multiple girder bridges.

4. When examining other similar details, look carefully for breaks in the paint and the formation of oxide dust at the location where the first crack originated.
5. If a suspect area is located in a detail found in many areas throughout the bridge, a more detailed examination of all such details will be carried out, such as performing magnetic particle testing, having the paint removed in the area and applying dye penetrant or a visual examination with a 10X power magnifier.
6. If the inspector feels that a crack in a steel member is a critical finding, or if the inspector is uncertain whether a crack is a critical finding, refer to Section 5.2 for guidance.

In the office:

1. Evaluate the significance of the crack on the load-carrying capacity of the bridge, considering the crack size, known material characteristics, and temperature. Steel is much more brittle during periods of extreme low temperature, and brittle fracture is more likely to occur in cold weather than during warm weather.
    - If the crack is moving perpendicular to the stress field in the member, it is desirable to arrange to have holes drilled, at the crack ends, immediately. The edge of the holes will be placed at the presumed end of the crack. After holes are drilled, it is desirable to check the hole to ensure that the crack tip has been removed and does not pass through the hole. This is generally a r retrofit pending development of a permanent repair.
2. Determine if special nondestructive tests are desirable at other locations (e.g., dye penetrant, mag-particle, ultrasonic testing or a more thorough visual examination).
3. Review results of examination of other locations on the bridge. Determine if a pattern develops related to truck traffic lanes and geometry of the structure.
4. Determine if the crack or cracks have developed from normal fabrication conditions or as result of an unusual flaw.

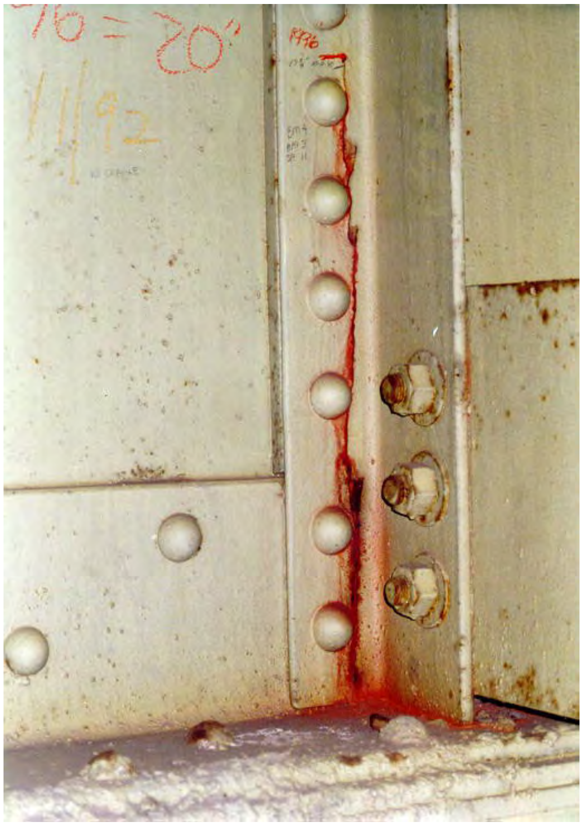


Figure 5.7-29 Fatigue Crack in a Diaphragm Connection Angle on a Girder.

Figure 5.7-28 Fatigue Crack Through the Bottom Flange of a Rolled Stringer at the End of a Partial Length Welded Cover Plate. (A stop hole has been drilled in the web and splice plates have been bolted to the bottom flange.)

5.7.9 Steel Girders and Floorbeam Systems

References: BIRM Sections 10.1.5, 10.2, 10.3, and 10.4
MDT Hands-On Inspection of Steel Members

5.7.9.1 Inspection and Documentation Requirements

Initial/Inventory Inspections & Routine Inspections

Inspection

- Inspect the superstructure in accordance with BIRM Sections 10.1.5, 10.2, 10.3, and 10.4.
- Note that for this type of superstructure, these inspections will typically be performed in conjunction with Nonredundant Steel Tension Member Inspections. As such, refer to each structure’s Nonredundant Steel Tension Member Inspection Plan for inspection procedures, methods, proximity, etc., for the inspection of the various superstructure members. Inspection procedures below are general, but applicable to most members. Also refer to the Nonredundant Steel Tension Member Inspection Requirements below for items specific to Nonredundant Steel Tension members.
- Suspect areas will be inspected "hands-on" to determine the type and extent of deterioration or deficiency. Use additional light and magnification to evaluate the member if necessary.
- Compression flanges will be inspected for flange buckling due to overloads.

- Section loss, gouges, dings, and impacted rust are all stress risers in steel members and will be inspected closely.
- Webs will be inspected for signs of web crippling (out-of-plane bending) at all support locations. Where visual observation indicates the possibility of distortion in the web, the web will be checked with a plumb bob.
- All welded repairs, connections, cover plates, utility connections and any other miscellaneous welds in the tension zone of non-NSTMs will be inspected "hands-on" for fatigue cracks or other defects.
- All suspected cracks will undergo Nondestructive Testing (NDT) to confirm their existence and determine the extent of the crack.
- Bolts and rivets will be visually checked for tightness and section loss. Broken paint or bleeding rust around the bolt or rivet may indicate a loose or broken fastener. Suspect fasteners will be tapped with a hammer to confirm their integrity.
- Check the non-NSTM connections for fatigue cracks due to out-of-plane bending.
- Lateral bracing gusset plate connections in tension zones of non-NSTMs will be inspected for fatigue cracks due to out-of-plane bending.
- When defects are found in a particular detail or location on a member, all other similar details or member locations will be inspected "hands-on" for the presence of similar defects.

Documentation

- Bullets below are for the documentation of all Elements that are not Nonredundant Steel Tension Members. See Nonredundant Steel Tension Member Inspections below for NSTM documentation guidance.
- Document the extent and severity of all rusting. Significant loss, whether from past or current rusting, will be noted in sufficient detail for a load rating analysis to be performed. Engineering judgement is required in the field to determine the significance of areas with loss, but as a guideline, specific notes are required when:
    a. Greater than 15% (typically 1/8”) of the flange thickness is lost in areas of high moment.
    b. Greater than 30% (typically 1/8”) of the web thickness is lost in areas of high shear.
    c. Less significant losses (typically <1/8”) will be noted, but exact measurements are not normally required.
- Document steel losses by noting the area and depth of the loss as well as its relative location along the length of the steel member, measured from a fixed point (e.g., *12” H x 12” W x 1/8” deep loss on the base of the girder G1, beginning 3’ from the west bearing on the north face of at abutment 2.*) Whenever possible, where deterioration is noted, calipers, D-meters, or other measuring devices will be used to measure the remaining section instead of estimating the loss. Notes will clearly indicate whether an "estimated loss" or measured remaining thickness is being given.
- Note locations and condition of welded repairs, connections, cover plates, utility connections and other miscellaneous welds in the tension zones of the steel members.
- Determine the approximate percentage of bolts/rivets with section losses in the head/bolt and document extent of loss (e.g., *20% of rivets exhibit 10% head loss or all rivets at deck joints exhibit 50% head loss*).
- Document, in the field notes, locations of loose bolts/rivets found and mark locations on the bridge with a permanent marker or lumber crayon along with the date found.

- Document locations and lengths of all cracks found. Mark these locations on the bridge with permanent marker or lumber crayon. Note the date found and the extent of the crack in such a manner that subsequent inspections may determine additional crack propagation. The method of inspection will also be noted as the crack may have propagated farther than may show visually. If any retrofit has been made to an old crack or holes drilled to arrest existing cracks, evaluate the effectiveness of the retrofit and note whether the crack has propagated past the arresting hole.
- Specific care will be given to documenting the current condition of all previously noted problems so a rate of deterioration can be established for monitoring purposes. If increased quantity or size of deteriorations causes the condition rating to change from the last inspection, a photograph and explanation of why the rating has changed will be included in the inspection report.
- Significant changes in condition state or discovery of critical findings will be documented and reported in accordance with Section 5.2 of this manual.

Nonredundant Steel Tension Member Inspections

Inspection

- Per the NBIS, Nonredundant Steel Tension Member Inspections are to be performed at regular intervals, not exceeding 24 months. However, certain Nonredundant Steel Tension members may require an inspection frequency less than 24 months.
- Refer to each bridge's Nonredundant Steel Tension Member Inspection Plan for inspection procedures, methods, proximity, etc., for the inspection of the various superstructure members.
- Inspection procedures note above for Initial/Inventory & Routine Inspections, noted above, generally apply.
- If a crack is found in a NSTM, NDT will be performed as necessary to find the limits of the cracking and MDT will then be notified immediately from the field. See Section 5.2 for additional guidance for what to do when a crack is found.

Documentation

- Document the type, size, and location of all defects along the NSTMs on the Nonredundant Steel Tension Member Sketches from the Nonredundant Steel Tension Member Inspection plan. See Initial/Inventory Inspection bullets above for an example of a defect note with a location call-out. Document the locations and condition of welded repairs, connections, cover plates, utility connections and other miscellaneous welds in the tension zones of the NSTMs on the Nonredundant Steel Tension Member Sketches.
- The Nonredundant Steel Tension Member Inspection Plan and associated Nonredundant Steel Tension Member Sketches will be uploaded to the BrM Multimedia Tab.

Damage Inspections

Inspection

- Inspection methods will vary depending on the type and severity of damage. Damaged areas caused from vehicle live loads, will be inspected for tears, distortions, or cracks. Supports, adjacent areas and welds in the vicinity will be inspected for signs of overstress or damage.
- The damage inspection will be coordinated between the inspector, bridge owner, and any other relevant agencies to determine the scope of damage and planned inspection methods.

Documentation

- Thoroughly document the condition of all damaged members. Any damage along Nonredundant Steel Tension Member members will be noted on the Nonredundant Steel Tension Member Sketches.
- Photographs of the damaged areas are required.
- As stated in Section 4.1.6 of this manual, damage inspections are typically used in the decision-making process for implementing or lifting emergency load posting restrictions or bridge closures.

5.7.9.2 Report Review

- Review the inspection findings in accordance with established Quality Control and Quality Assurance procedures.
- The inspection report reviewer will determine if the pattern, quantity, and severity of the deteriorations found support the numerical condition rating given. The reviewer will compare the present inspection report to past reports.
- The inspection reviewer will determine if fatigue problems have been noted and whether patterns of deterioration or progressive deterioration are taking place. If fatigue cracks are noted, the reviewer will ensure that procedures for reporting critical deficiencies have been initiated, if warranted. Rate of deterioration progression will be determined by comparing present to past inspection reports.
- The appearance of new, or the sudden propagation of existing, fatigue cracks may warrant a new load or fatigue analysis and/or load posting of the bridge structure. A note will be placed in the report stating that fatigue problems are evident and that they will be monitored closely.

5.7.9.3 Maintenance Considerations

- Most repairs to steel members will be structural in nature and may have an effect on the load carrying capacity of the structure. Repairs will be detailed and performed under the direction of a qualified engineer.
- Fatigue cracks, that show little or no crack propagation for extended periods, can suddenly resume propagation possibly resulting in member failure. Therefore, all cracks found will be immediately reported and corrective action will be taken as soon as possible to ensure the integrity of the structure and safety of the public.
- Areas of section loss, gouges, dings, and impacted rust are all stress risers in steel members and will be monitored closely or repaired.
- Areas of severe rusting will be cleaned and coated to prevent further deterioration.

Figure 5.7-30 Typical Framing on a Girder-Floorbeam-Stringer Superstructure.

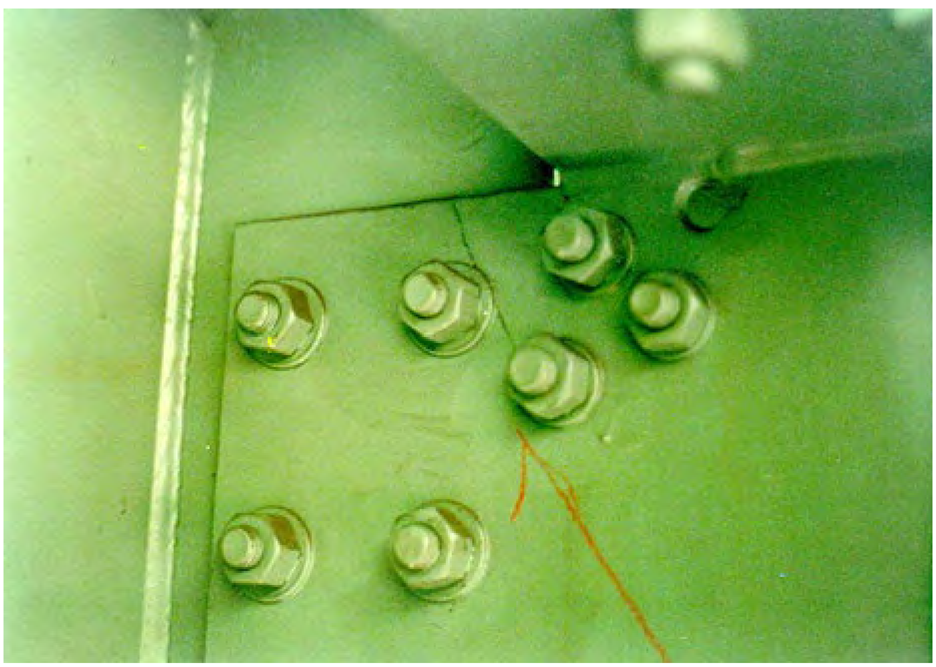


Figure 5.7-31 Fatigue Cracks in the Web of a Floorbeam at the Top Flange Cope. Stopper holes have been drilled and bolts installed in the holes.

5.7.10 Steel Box Girders

References: BIRM Sections 10.1.4, 10.2, 10.3 and 10.4

MDT Hands-On Inspection of Steel Members

5.7.10.1 Inspection and Documentation Requirements

Safety Precautions: Inspection of the interiors of box beams requires additional safety precautions:

- Adequate lighting is required along with backup flashlights for emergency use.
- Air quality will be checked before entering the box girder in conformance with Confined Space procedures.
- It is important that at least one (1) crew member remain outside of the box to be able to obtain emergency help if necessary. This person will monitor the inspection progress from the hatch entrance and will not enter the box until help is sent for, and then only if it is safe to do so.
- Many boxes contain dust and pigeon debris. Dust masks will be worn if this material is present during the inspection. If the amount of debris is too great for safe inspection or obscures your vision of the areas to be inspected, then arrangements will be made for Maintenance to clean the box.

Initial/Inventory Inspections & Routine Inspections

Inspection

- Inspect the steel box girders in accordance with BIRM Chapter 10, Sections 10.1.4, 10.2, 10.3 and 10.4.
    - Steel members that are not Nonredundant Steel Tension Members are required to receive a hands-on inspection for their first and second inspections after construction. After the first two inspections, hands-on access may be reduced. Refer to MDT Hands-On Inspection of Steel Manual for the inspection frequency table, after which these elements will be inspected from a distance that is appropriate to identify and evaluate defects consistently and accurately for weather conditions, light conditions, and the defect type/severity.
    - Bullets below are for the inspection of all non-NSTM and/or box girder bridges with at least three steel box girders. See Nonredundant Steel Tension Member Inspections below for NSTMM inspection guidance (bridges with only one or two box girders).
- Particular attention will be given to all connections along the box girder, both internal and external.
- The interiors of the box girders will be inspected full length, with sufficient light and visibility to detect hairline cracks greater than 1/2" in length in any portion of the box.
- All drain holes in the box beam will be checked to ensure they are clear of debris. All drainpipes that pass through the box girder will be checked to ensure that they are not leaking into the box girder.

Documentation

- Bullets below are for the inspection of all non-NSTM Elements and/or box girder bridges with at least three steel box girders. See Nonredundant Steel Tension Member Inspections below for NSTM inspection guidance (bridges with only one or two box girders).
- Note any deficiencies or deterioration found. These may be described in narrative form, however, where defects cannot be simply described, sketches will be prepared. Significant deficiencies, such as impact damage, section loss, fatigue cracks, etc., will be located on a framing plan, either sketched or copied from the plans.
- If cracks are detected, at least one sketch and photo will be made of each type found. Other similar cracks can be noted in narrative form. The ends of cracks will be marked for monitoring.

- Note the extent and severity of any rusting. Significant loss, whether from past or current rusting, will be noted in sufficient detail for a load rating analysis to be performed. Engineering judgment is required in the field to determine the significance of areas with loss, but as a guide, specific notes are required when:
    - Greater than 15% (typically 1/8") of the flange thickness is lost in areas of high moment.
    - Greater than 30% (typically 1/8") of the web thickness is lost in areas of high shear.
    - Less significant losses (typically < 1/8") will be noted, but exact measurements are not normally required.
- Document steel losses by noting the area and depth of the loss as well as its relative location along the length of the beam measured from a fixed point (e.g., *12" H x 12" W x 1/8" deep loss on girder web at the bottom flange, beginning 3' from the west bearing on girder G1*). Whenever possible, where deterioration is noted, calipers, D-meters or other measuring devices will be used to measure the remaining section instead of estimating the loss. Notes will clearly indicate whether an "estimated loss" or measured remaining thickness is being given.
- Care will be given to documenting increased quantity or size of previously noted deteriorations that have changed since the last inspection. If the condition rating has changed since the last inspection (up or down), a photograph or explanation of why the rating was changed will be included.
- Notes will be made describing the current condition of any item previously discovered and noted for monitoring.
- Significant changes in condition state or discovery of critical findings will be documented and reported in accordance with Section 9.3.3 or Section 5.2 of this manual.

Nonredundant Steel Tension Member Inspections

Inspection

- This applies to box girder bridges comprised of one or two box girders.
- Nonredundant Steel Tension Member Inspections will be performed per the procedures described in the bridge's custom Nonredundant Steel Tension Member Inspection Plan. See Appendix 4G for template.
- Perform "hands-on" inspection of all Nonredundant Steel Tension Member members on the bridge with the use of visual inspection methods where the inspector is about 24" from the surface. In some cases, supplemental non-destructive inspections may be necessary.
- See Initial/Inventory Inspection guidance above and apply those inspection procedures to NSTMs, except that inspection will be hands-on. Use additional light and magnification to evaluate the member if necessary.
- Per the NBIS, Nonredundant Steel Tension Member Inspections are to be performed at regular intervals, not exceeding 24 months. However, certain NSTMs may require an inspection frequency less than 24 months.
- If a crack is found in an NSTM, NDT will be performed as necessary to find the limits of the cracking and MDT will then be notified immediately from the field. See Section 5.2 for additional guidance for what to do when a crack is found.

Documentation

- Document the type, size, and location of all defects along the NSTMs on the Nonredundant Steel Tension Member Sketches from the Nonredundant Steel Tension Member Inspection Plan. See

Initial/Inventory Inspection bullets above for an example of a defect note with a location call-out.
- Document the locations and condition of welded repairs, connections, cover plates, utility connections and other miscellaneous welds in the tension zones of the NSTM's on the Nonredundant Steel Tension Member Sketches.
- The Nonredundant Steel Tension Member Inspection Plan and associated Nonredundant Steel Tension Member Sketches will be uploaded to the BrM Multimedia Tab.

Damage Inspections

Inspection

- Inspection methods will vary depending on the type and severity of damage. Damage caused by a vehicle collision with a steel box girder, such as gouging or distortion, may require a more involved inspection than damage inflicted by alternate means.
- The damage inspection will be coordinated between the inspector, bridge owner, and any other relevant agencies to determine the scope of damage and planned inspection methods.

Documentation

- Thoroughly document the condition of all damaged members. Any damage along NSTMs will be noted on the NSTM Sketches.
- Photographs of the damaged areas are required.
- As stated in Section 4.1.6 of this manual, damage inspections are typically used in the decision-making process for implementing or lifting emergency load posting restrictions or bridge closures.

5.7.10.2 Report Review

- Review the inspection findings in accordance with established Quality Control and Quality Assurance procedures.
- The inspection report reviewer will determine if the pattern, quantity, and severity of the deteriorations found support the numerical condition rating given. The reviewer will compare the present inspection report to past reports.
- Sudden or progressive geometric displacements, loss of greater than 15% of the flange thickness in areas of maximum moment, or loss of greater than 30% of the web thickness in bearing areas may indicate the need for a new load rating analysis and/or posting of the structure for a weight restriction.

5.7.10.3 Maintenance Considerations

- To prevent the intrusion of pigeons and other birds, all hatches will normally be kept closed. All openings large enough to permit the entry of birds will be covered with wire mesh.
- Drain holes will be kept clear to prevent the buildup of water in the boxes. The cause of any leakage into the box girders will be investigated and corrected.
- Most repairs to steel members will be structural in nature and may have an effect on the load carrying capacity of the structure. Repairs will be detailed and performed under the direction of a qualified engineer.
- Fatigue cracks, that show little or no crack propagation for extended periods, can suddenly resume propagation, possibly resulting in member failure. Therefore, all cracks found will be immediately reported and corrective action will be taken as soon as possible to ensure the integrity of the structure and safety of the public.

- Areas of section loss, gouges, dings, and impacted rust are all stress risers in steel members and will be monitored closely or repaired.
- Areas of severe rusting will be cleaned and coated to prevent further deterioration.

Figure 5.7-32 Curved Steel Box Girder Bridge.

Figure 5.7-33 Inside Steel Box Girder.

5.7.11 Trusses and Metal Arch Bridges

References: BIRM Sections 10.1.6, 10.1.7, 10.2, 10.3, and 10.4

MDT Hands-On Inspection of Steel Members

5.7.11.1 Inspection and Documentation Requirements

General Inspection

- General inspection requirements of Trusses and Metal Arches are shown below. Following general inspection procedures below for all the different bridge elements, there are inspection access proximity requirements for Inventory Inspections (non-NSTM), as well as Nonredundant Steel Tension Member inspections.
- Note that for these types of superstructure, these inspections will typically be performed in conjunction with Nonredundant Steel Tension Member Inspections. As such, refer to each structure's Nonredundant Steel Tension Member Inspection Plan for inspection procedures, methods, proximity, etc., for the inspection of the various superstructure members. Inspection procedures below are general, but applicable to most members. Also refer to the Nonredundant Steel Tension Member Inspection Requirements below for items specific to nonredundant steel tension members.
- Inspect the trusses and metal arches in accordance with BIRM Sections 10.1.6, 10.1.7, 10.2, 10.3, and 10.4.
- All superstructure elements will be accessed from all sides to inspect for corrosion, impacted rust, section loss, cracks, dings, gouges, impact damage and other defects. Emphasis will be placed on truss member connections, areas of maximum moment, maximum shear, maximum axial load, locations of fatigue sensitive details, bearing areas and floor system connections.
- Suspect areas will be inspected hands-on to determine the type and extent of deterioration or deficiency.
- Bolts and rivets will be visually checked for tightness and section loss. Broken paint or bleeding rust around the fastener may indicate a loose or broken fastener. Suspect fasteners will be tapped with a hammer to confirm their integrity.
- When defects are found in a particular detail or location on a member, all other similar details or member locations will be inspected hands-on for similar defects.
- Section loss, gouges, dings, and impacted rust are all stress risers in steel members and will be monitored closely.
- All suspected cracks will undergo NDT to confirm their existence and determine the extent of the crack. Mark any cracks on the bridge with a permanent marker or lumber crayon.

Floor System Inspection

- Girders, floorbeams and stringers that comprise the floor system of trusses, deck arches and through arches will be inspected in accordance with the guidelines outlined in Section 5.7.9 Steel Girder and Floorbeams.

Pin Inspection

- Pin and hanger details will be inspected in accordance with Section 5.7.2 of this manual.
- Inspect all panel point pins for corrosion, impacted rust and signs of scoring and wear (abrasion dust). Ultrasonic testing will be performed in accordance with Section 5.5.4 of this manual.
- Inspect spacer plates, nuts, retaining caps, cotter pins and keys for proper positioning, alignment, and installation. Check that pin nuts are fully threaded onto the pins.
- Inspect all pins for signs of rotation. Abrasion dust around the nut or spacer plates is an indicator that rotation occurs. Cracked paint around pin nuts may indicate rotation or may

indicate the nut is loose. If this condition is noted, the nut will be tapped with a hammer to determine tightness.

Truss and Metal Arch Tension Member Inspections

- This section will cover all truss tension members, as well as axially loaded members that are in a constant state of tension in braced ribbed and spandrel braced deck and through arches.
- Members that undergo force reversal will also be inspected as tension members.
- Inspect all tension members for signs of corrosion, section loss, wear, impacted rust, fatigue induced cracks, impact damage, signs of misalignment, debris build up, loose, missing, or deteriorated fasteners, and other deterioration.
- Check alignment of tension members. Buckling or bowing due to causes other than impact, may be indicative of permanent force reversal, and may be caused by settlement, tilting or other displacement of the substructure elements. If bowing or buckling is observed, a thorough investigation as to the causes and effects will be conducted.
- All welded repairs, connections, cover plates, utility connections and any other miscellaneous welds on tension members will be inspected "hands-on" for fatigue cracks or other defects. Particular attention will be placed on inspection of welds that are transverse to the direction of applied stress.
- Inspect counter members to see if they are laterally movable by hand. Counters are designed to be stressed during live load application only. Inability to move counters during dead load application only indicates that unanticipated loads are being applied to the member.
- Inspect counter eyebars within a panel for contact, abrasion dust or wear between the eyebars at the cross over.
- Inspect eyebars for corrosion and cracks along their entire length. Particular attention will be paid to forged joints between rolled bars and their cast eye.
- Inspect threaded rod eyebars and turnbuckles for corrosion, impacted rust, tack welds and cracks. Inspect the threaded portion of the rod for signs that the turnbuckle is loosening.

Truss Compression Member and Metal Arch Rib Inspection

- This section will cover all truss compression members as well as axially loaded members that are in a constant state of compression in braced ribbed deck and through arches.
- Inspect all compression members for signs of buckling, web crippling, corrosion, section loss, impacted rust, collision damage, wrinkles or waves in flanges, welds, misalignment, debris buildup, loose, missing, or deteriorated fasteners or other deterioration. Buckling, warping, wrinkling, etc., may indicate member overstress. Section loss, tears, misalignment, etc., may result in possible loss of load capacity. Both conditions warrant analysis to determine the effects on the structure.
- Inspect the condition of lacing bars, stay plates and batten plates. Note that the condition of these items will not normally be considered when assigning a condition rating to the compression member. However, if deterioration extends into the compression member base metal or if the alignment of compression member components is affected (impacted rust causing bent flanges, web plates, etc.), sound judgment will be used to determine if and to what extent the condition rating will be adjusted.
- Truss top chord members that are integral with the bridge deck or that support portions of the floor system between panel points, will be inspected as both axially loaded and bending members.
- Inspect all splice plates for loose, missing, or deteriorated fasteners, cracks, and impacted rust.

Gusset Plate Inspection

- Inspect gusset plates closely for any signs of deterioration (corrosion, impacted rust, distortion, cracking, debris accumulation, etc.).
- Closely inspect the exterior lines of rivets/bolts at right angles to the applied stress.

Spandrel Member Inspection

- Inspect the spandrel columns for signs of buckling, corrosion, impacted rust at connections, and loose, missing, or deteriorated fasteners.
- Inspect the spandrel columns for fatigue cracks at floorbeam connections.

Cable Hanger Inspection

- In addition to the inspection requirements of this section, cable hangers will be inspected in accordance with the guidelines given for Truss and Metal Arch Tension Members, and in Section 5.3 for Nonredundant Steel Tension Members.
- Inspect the cable hangers for corrosion, broken or misaligned wire strands, collision damage, welded attachments, and proper alignment.
- Note locations where superstructure steel, utility supports, or other members are in hard contact with the cable hangers and note the extent of any abrasion caused by this contact.
- Inspect the cable hanger connection details to the truss and floor system or tie girder for fatigue induced cracks, loose, missing, or broken fasteners, misalignment, debris buildup, corrosion, and other deterioration.

Secondary Member Inspection

- Inspect the top chord bracing, bottom chord bracing, floor system lateral bracing, sway bracing and knee braces for cracks, corrosion, impacted rust, loose, missing or deteriorated fasteners, proper alignment, debris buildup, impact damage and other deterioration.

Initial/Inventory Documentation (Non-NSTMs)

- Steel members that are not NSTMs are required to receive a hands-on inspection for their first and second inspections after construction. After the first two inspections, hands-on access may be reduced. Refer to MDT Hands-On Inspection of Steel Manual for the inspection frequency table, after which these elements will be inspected, using the procedures noted above, from a distance that is appropriate to identify and evaluate defects consistently and accurately for weather conditions, light conditions, and the defect type/severity.
- Document all steel losses by noting the area and depth of the loss as well as the relative location along the length of the member measured from a fixed point (e.g., 12” H x 12” W x 1/8” deep loss on the north elevation of the stringer 3 web, starting at the connection to floorbeam 4. Whenever possible, where deterioration is noted, calipers, D-meters or other measuring devices will be used to measure the remaining section instead of estimating the loss. Notes will clearly indicate whether an "estimated loss" or measured remaining thickness is being given.
- Document the locations and condition of all welded repairs, connections, cover plate ends, utility connections and other miscellaneous welds on all steel members and in tension zones of members.
- Determine and document the approximate percentage of bolts/rivets with section loss in the head/bolt and document the extent of the loss (e.g., 20% of rivets exhibit 10% section loss).
- Document the locations of all loose bolts/rivets and mark locations on the bridge with a permanent marker or lumber crayon along with the date found.
- Document locations and lengths of all cracks found. Note the date found and the limit of crack propagation in such a manner that subsequent inspections may determine additional crack

propagation. The method of inspection will also be noted as the crack may have propagated farther than may show visually. If any retrofit has been made to an old crack or holes drilled to arrest existing cracks, evaluate the effectiveness of the retrofit and note whether the crack has propagated past the arresting hole.
- Specific care will be given to documenting the current condition of all previously noted problems so a rate of deterioration can be established for monitoring purposes. If increased quantity or size of deteriorations causes the condition rating to change from the last inspection, a photograph and explanation of why the rating has changed will be included in the inspection report.
- The results of all NDT performed will be included in the inspection report.
- Significant changes in condition state or discovery of critical findings will be documented and reported in accordance with Section 9.3.3 or Section 5.2 of this manual.

Nonredundant Steel Tension Member Inspections

Inspection

- Nonredundant Steel Tension Member Inspections will be performed per the procedures described in the bridge's custom Nonredundant Steel Tension Member Inspection Plan.
- Perform "hands-on" inspection of all Nonredundant Steel Tension Members on the bridge with the use of visual inspection methods where the inspector is about 24" from the surface. In some cases, supplemental non-destructive inspections may be necessary.
- See General Inspection guidance above and apply those inspection procedures to NSTM's, except that inspection will be hands-on. Use additional light and magnification to evaluate the member if necessary.
- Per the NBIS, Nonredundant Steel Tension Member Inspections are to be performed at regular intervals, not exceeding 24 months. However, certain NSTMs may require an inspection frequency less than 24 months.
- If a crack is found in a NSTM, NDT will be performed as necessary to find the limits of the cracking and MDT will then be notified immediately from the field. See Section 5.2 for additional guidance for what to do when a crack is found.

Documentation

- Document the type, size, and location of all defects along the NSTM's on the Nonredundant Steel Tension Member Sketches from the Nonredundant Steel Tension Member Inspection plan. See Initial/Inventory Inspection bullets above for an example of a defect note with a location call-out.
- Document the locations and condition of welded repairs, connections, cover plates, utility connections and other miscellaneous welds in the tension zones of the NSTM's on the Nonredundant Steel Tension Member Sketches.
- The Nonredundant Steel Tension Member Inspection Plan and associated Nonredundant Steel Tension Member Sketches will be uploaded to the BrM Multimedia Tab.

Damage Inspections

Inspection

- Inspection methods will vary depending on the type and severity of damage. Damaged areas caused from vehicle live loads, will be inspected for tears, distortions, or cracks. Supports, adjacent areas and welds in the vicinity will be inspected for signs of overstress or damage.

- The damage inspection will be coordinated between the inspector, bridge owner, and any other relevant agencies to determine the scope of damage and planned inspection methods.

Documentation

- Thoroughly document the condition of all damaged members. Any damage along Nonredundant Steel Tension members will be noted on the Nonredundant Steel Tension Member Sketches.
- Photographs of the damaged areas are required.
- As stated in Section 4.1.6 of this manual, damage inspections are typically used in the decision-making process for implementing or lifting emergency load posting restrictions or bridge closures.

5.7.11.2 Report Review

- Review the inspection findings in accordance with established Quality Control and Quality Assurance procedures.
- The inspection report reviewer will determine if the pattern, quantity, and severity of the deteriorations found support the numerical condition rating given. The reviewer will compare the present inspection report to past reports.
- The inspection reviewer will determine if fatigue problems have been noted and whether patterns of deterioration or progressive deterioration are taking place. If fatigue cracks are noted, the reviewer will ensure that procedures for reporting critical deficiencies have been initiated. Rate of deterioration progression will be determined by comparing present to past inspection reports.
- The appearance of new, or the sudden propagation of existing, fatigue cracks may warrant a new load or fatigue analysis and/or load posting of the bridge structure. A note will be placed in the report stating that fatigue problems are evident and that they will be monitored closely.

5.7.11.3 Maintenance Considerations

- Most repairs to steel members will be structural in nature and may have an effect on the load carrying capacity of the structure. Repairs will be detailed and performed under the direction of a qualified engineer.
- Fatigue cracks, that show little or no crack propagation for extended periods, can suddenly resume propagation, possibly resulting in member failure. Therefore, all cracks found will be immediately reported and corrective action will be taken as soon as possible to ensure the integrity of the structure and safety of the public.
- Areas of section loss, gouges, dings, and impacted rust are all stress risers in steel members and will be monitored closely or repaired.
- Areas of severe rusting will be cleaned and coated to prevent further deterioration.

Figure 5.7-34 Historic Steel Through Truss Bridge.

Figure 5.7-35 Steel Deck Arch Bridge.

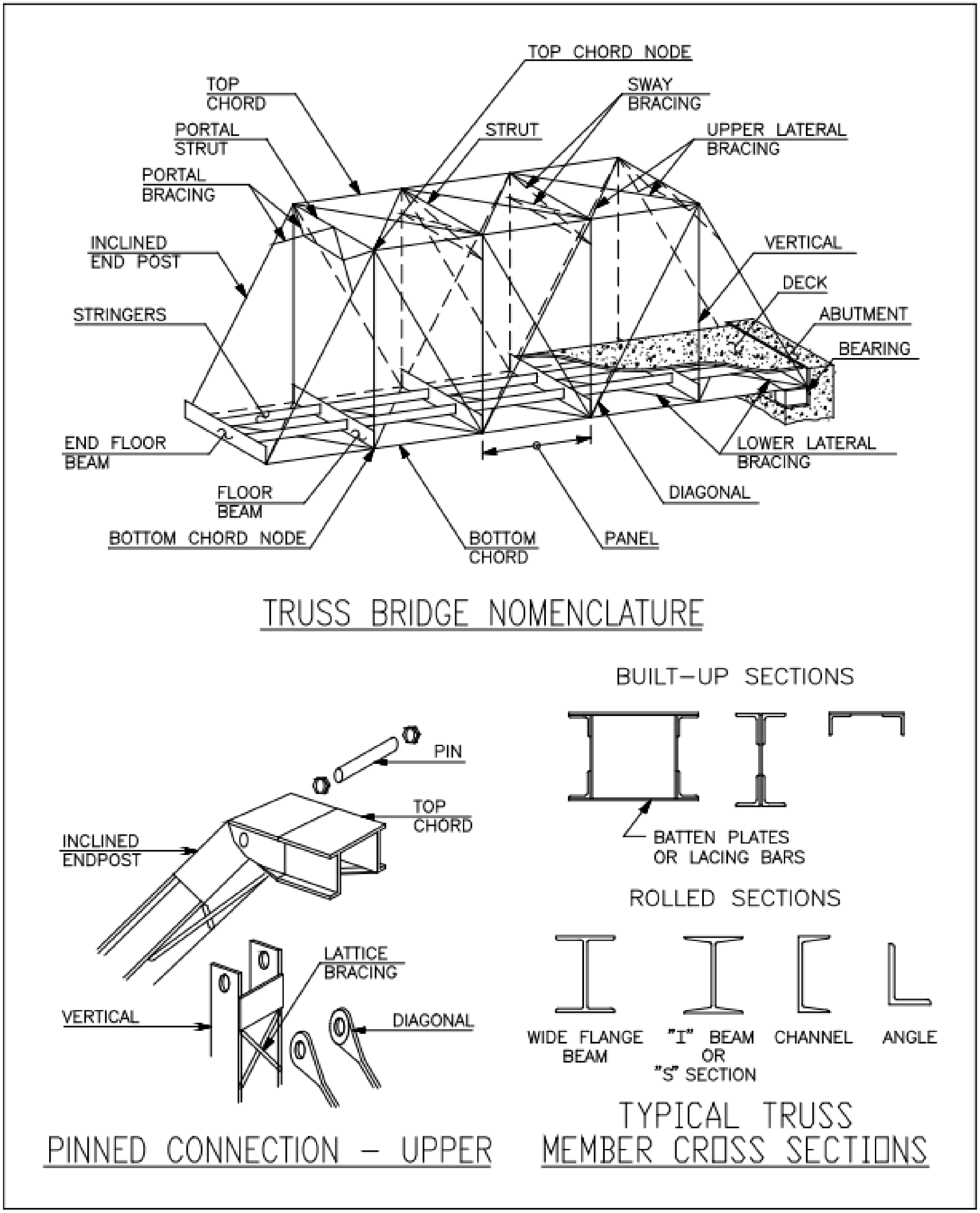


Figure 5.7-36 Truss Bridge Nomenclature and Details.

5.7.12 Timber Superstructures

Reference: BIRM Chapter 11, USDA Forest Service Publication "Timber Bridges: Design, Construction, Inspection and Maintenance"

5.7.12.1 Inspection and Documentation Requirements

Initial/Inventory Inspections & Routine Inspections

Inspection

- Inspect the timber superstructure in accordance with BIRM Chapter 11.
- The entire superstructure will be inspected from a distance that is appropriate to identify and evaluate defects consistently and accurately for weather conditions, light conditions, defect type and severity.
- Inspect timber members for signs of crushing at bearing areas and at stringer/floorbeam connections. Look for signs of overstress in areas of maximum bending stress, such as cracks extending from the bottom surface of simply supported areas near midspan. Cracks are also commonly seen extending from knots in tension zones.
- Inspect for decay (discoloration, soft spots) and parasite damage at ends of members where dirt, debris, and moisture tend to accumulate and at the superstructure/deck interface. Deteriorated areas may also occur at locations of field constructed connections where the paint or preservative system has been damaged or disrupted. Areas that have evidence of serious deterioration, decay or infestation will be considered for possible further investigation by Non-Destructive Testing (NDT) and Destructive Testing (DT) methods (such as Resistivity Drilling or Increment Boring).
- Hammer tap or probe with a sharp object 25% of all surface areas showing no apparent deterioration to determine soundness of member. *Be careful of frozen timber that may have internal deterioration but sounds solid due to water frozen in the internal cavities.*
- For localized fire damage, Inspect the fire-damaged areas, removing the charring to reveal the remaining section and expose undamaged wood for defects hidden by charring. Note that if the fire damage is not localized and/or new, a Damage Inspection may be required, and the inspector will consult MDT if uncertain.
- Check for horizontal shear cracks/splits in solid sawn members and delamination between laminas in glue-laminated members. Horizontal shear cracks/splits and delaminations at mid-height of the member are more critical than those nearer the top or bottom surface. Horizontal cracks will cause the member to act as two smaller members, independent of each other, in the vicinity of the crack or delamination.
- Secondary members may be timber or steel members. For timber, check for deterioration, proper fit, cracked or split members and corroded, loose, or missing fasteners. For steel members, check for section loss, loose or missing fasteners, and bowing or buckling of the member.
- Timber members are best connected with seated, bearing type connections. Check bolted, framed, or nailed connections for member deterioration or connection failure.
- Areas on the underside of the deck that are below repaired, or deteriorated areas of the wearing surface or overlay will be inspected "hands-on" to evaluate the condition of the repair or limits of deterioration.
- Check primary members for excessive deflection, sagging and bounce as well as for proper alignment.
- Evaluate the condition and effectiveness of the roof and siding of covered bridges as well as the protective coating (paint or pressure treatment).

Documentation

- Document all deterioration such as debris build-up, fungus growth, parasite infestation, fire damage, impact or collision damage, weathering and warping, splitting, cracking, checking, chemical damage, isolated fire damage, and signs of overstress. All deteriorations noted will include the size and relative location on the member. Where possible, measurements will be taken to determine the remaining effective section of the member.
- Document any horizontal shear cracks, splits, or delaminations in bending members. Note whether the cracks, splits, or delaminations pass entirely or partially through the member and measure the depth of the crack, if possible. Also dimension the height of the member halves above and below the crack, as well as the member base and the amount that the crack has opened.
- A simple framing plan will be provided showing locations of deteriorations and other noted problems. Member elevations and sections will be provided as required to adequately document the deterioration or other problems found.
- Care will be given to documenting any increased quantity or size of deteriorations that have changed since the last inspection. If the condition rating has changed since the last inspection, a photograph and explanation of why the rating has changed will accompany the inspection report.
- Notes will be made describing the current condition of all previously noted problems so that a rate of deterioration can be established for monitoring purposes.
- Significant changes in condition state or discovery of critical findings will be documented and reported in accordance with Section 5.2 of this manual.

Damage Inspections

Inspection

- Inspection methods will vary depending on the type and severity of damage. For example, the inspection performed in response to a vehicular collision with a timber superstructure might differ from that performed following a fire beneath a timber structure.
- The damage inspection will be coordinated between the inspector, bridge owner, and any other relevant agencies to determine the scope of damage and planned inspection methods.

Documentation

- Thoroughly document the condition of any superstructure element that has been damaged.
- Photographs of the damaged areas are required, and sketches are required if text alone cannot easily convey the scope of the damage.
- As stated in Section 4.1.6 of this manual, damage inspections are typically used in the decision-making process for implementing or lifting emergency load posting restrictions or bridge closure.

5.7.12.2 Report Review

- Review the inspection findings in accordance with established Quality Control and Quality Assurance procedures.
- The inspection report reviewer will determine if the pattern, quantity, and severity of the deteriorations found support the numerical condition rating given. The reviewer will compare the present inspection report to past reports.
- Review all field notes to determine if further non-destructive testing and/or destructive testing is warranted.

5.7.12.3 Maintenance Considerations

- The most common type of preventive maintenance for wood structures is to deny the timber food source to any fungi or parasites. This is done through application of preservative treatment, paint, or other protective coatings.
- Pressure treatments typically do not penetrate through the entire cross-section of the member. Therefore, as with non-treated members, interior deterioration due to parasite infestation may still occur despite the solid appearance of the exterior.
- Loose connections may occur due to timber shrinkage, cracking, checking, decay, or crushing around the connector. These connectors may need to be tightened or replaced with larger connectors over time.
- Clean debris to avoid moisture accumulation.
- Cut vegetation from around wet areas and areas prone to debris buildup to better allow air circulation for drying action.

Figure 5.7-37 Elevation View of a Solid Sawn Timber Bridge.

Figure 5.7-38 Underside View of a Solid Sawn Multi-Beam Timber Bridge.

5.7.13 Stone Masonry Arches

Reference: BIRM Sections 11.2.4 and 11.5.2

5.7.13.1 Inspection and Documentation Requirements

Note: Stone masonry arches may have concrete, stone or other type of construction for the spandrel portion of the arch structure. Spandrels that are comprised of stone masonry will be inspected in accordance with this section. Spandrels constructed of concrete will be inspected according to the guidelines outlined in Section 5.7.5, Concrete Rigid Frames and Closed Spandrel Arches.

Initial/Inventory Inspections & Routine Inspections

Inspection

- Inspect the superstructure in accordance with BIRM Sections 11.2.4 and 11.5
- The entire stone masonry arch superstructure will be inspected from a distance that is appropriate to identify and evaluate defects consistently and accurately for weather conditions, light conditions, defect type and severity. All problem areas observed will be subsequently inspected "hands-on" to determine the extent of the deterioration.
- Inspect the arch stones for signs of possible failure from any of the following failure modes:

    1. Crushing of stones (See the special note below).
    2. Sliding of one arch stone on another.
    3. Rotation of an arch stone, or series of arch stones, about an edge of a joint creating an opening at the joint.

- Probe areas where joint mortar is missing to determine the average depth of loss and the location of maximum loss.

- Stones adjacent to joints with missing mortar will be inspected for displacement, tilting, cracking, heaving, spalling, and crushing due to the freeze thaw effects of penetrating water and the effects of non-uniform bearing pressure.
- Check stones that have experienced cracking to determine whether the pieces are still in tight contact with the adjacent stones and still providing adequate stability to the arch.
- Where visible, inspect the footing areas for signs of displacement due to the horizontal forces induced by the arching action in the structure.
- Where visible, inspect the extrados area to see if a waterproof membrane is in place and functioning.
- Inspect the arch spandrel walls for distress (large shear cracks initiating from the arch stones) or deterioration (spalls, map cracking, delamination, loss of joint mortar, etc.)
- Check to see if the arch and spandrel walls are plumb. Visually sight along the walls and thru the arch barrel to try to detect bulges or deformations.
- Inspect the roadway for signs of cracking parallel to the center line of the arch as well as sagging and depressions. Also, look for signs that fill or asphalt has been used to level the roadway. This may indicate loss of backfill material.

Documentation

- Document all deficiencies and deteriorations observed. Dimensions will include the length, width, height, depth of loss, orientation, and location relative to a fixed, identifiable point.
- When deficiencies cannot be easily described or if the condition rating is a "4" or less, elevation drawings as well as topside and underside plan drawings will be provided to show the layout of the stone masonry joints and noted deterioration. Sectional views and detail drawings will be provided, as required, to adequately describe the extent of noted deficiencies.
- Note areas of water leakage (infiltration and exfiltration).
- Notes will be made describing the current condition of all previously noted problems so that a rate of deterioration can be established for monitoring purposes. If the condition rating has changed from the previous inspection due to increased quantity or size of deterioration or if the deterioration has been repaired, photographs, documentation, and an explanation of why the condition rating has changed will accompany the inspection report.
- Significant changes in condition state or discovery of critical findings will be documented and reported in accordance with Section 5.2 of this manual.

Underwater/Probe and Wade Inspections

For portions requiring underwater inspection:

Inspection

- Inspect in accordance with BIRM Chapter 16.2
- The same defects will be inspected for as noted above under “Initial/Inventory Inspections and Routine Inspections”.
- All elements in, or adjacent to, waterways will be checked for the presence of scour and undermining, especially at the interface of the base with earth. Scour will be checked by probing around the entire base of every element exposed to potential scour.
- Debris build-up or aggradation within or near the arch will be noted.

Documentation

- The same defects will be documented as noted above under "Initial/Inventory Inspections and Routine Inspections".
- An aggregate of the above water and below water condition will be considered when evaluating the overall condition rating for the arch.
- Photographs will be taken of any defect causing a condition rating of "4" or less.
- Photographs and/or explanations will also be provided when conditions warrant changing a rating number from a previous inspection (either up or down). Additional consideration will be added to include photographs of, but not limited to, inadequate waterways, ice jams or flows, debris, channel and structure alignment, and riprap conditions.
- Scour will be de documented with an elevation sketch, when required, showing locations of scour with reference to a fixed point on the affected structure.

Damage Inspections

Inspection

- Inspection methods will vary depending on the type and severity of damage. Damage caused from vehicle live loads, such as spalling and missing stones and mortar, may require only a visual examination at one location.
- The damage inspection will be coordinated between the inspector, bridge owner, and any other relevant agencies to determine the scope of damage and planned inspection methods.

Documentation

- Thoroughly document the condition of any Masonry element that has been damaged.
- Photographs of the damaged areas are required, and sketches are required if text alone cannot easily convey the scope of the damage.
- As stated in Section 4.1.6 of this manual, damage inspections are typically used in the decision-making process for implementing or lifting emergency load posting restrictions or bridge closures.

5.7.13.2 Report Review

- Review the inspection findings in accordance with established Quality Control and Quality Assurance procedures.
- The inspection report reviewer will determine if the pattern, quantity, and severity of the deteriorations found support the numerical condition rating given. The reviewer will compare the present inspection report to past reports.
- Crushing or spalling of the arch ring stones may be an indication the stone is being overstressed and is deteriorating. This may be caused by an increased loading condition or a shifting of the neutral axis within the stone. Any arch ring stone crushing warrants monitoring and consideration of more detailed analysis to determine any adverse effects on the integrity of the arch.
- Low condition ratings caused by extensive or widespread deterioration will be reasons to request supplemental testing or analysis to better determine the condition and stability of the stone masonry arch and whether rehabilitation or replacement is warranted.
- The sudden or progressive appearance of cracks or movements in the arch stones may indicate the need for a new load analysis and/or weight restriction of the bridge.

5.7.13.3 Maintenance Considerations

- Arches originally constructed without mortar between the stones ("dry laid") do not need to be pointed. Arches originally constructed with mortared joints, however, will normally have missing or deteriorated mortar repaired.
- The object of joint mortar, when incorporated into the design, is to furnish a cushion for adjacent stones that helps to distribute the pressure uniformly, relieve the stone of transverse stresses and relieve stresses from concentrated crushing pressures to which the projecting points are subjected when in contact with other stones. Therefore, loss of joint mortar can increase the stresses in the stone to the point where crushing or cracking may occur. Lost joint mortar will be replaced.
- Cracks in stones, cracks in joint mortar and openings in joints provide access to water seepage that can further deteriorate the stone or joint through freeze/thaw action or allow exfiltration of fill material. Consider all cracks and joint openings for injection or other repair depending on their location and proximity to the arch ring. Engineering judgment is required prior to conducting repair work to determine the extent and criticality of the problem, effects on public safety and cost/benefit ratio of the repair.

Figure 5.7-39 Stone Masonry Arch and Spandrel Wall

5.8 Substructure Inspection

5.8.1 Concrete Substructures

Reference: BIRM Chapter 14

5.8.1.1 Inspection Requirements

Initial/Inventory Inspections & Routine Inspections

Inspection

- Inspect the substructure in accordance with BIRM Sections 14.4-14.6.
- The entire substructure will be inspected from a distance that is appropriate to identify and evaluate defects consistently and accurately for weather conditions, light conditions, defect type and severity.
- Substructure elements will be carefully observed for delaminations, spalls, exposed reinforcing, patches, efflorescence, rust staining, cracking, abrasion/wear, settlement, scour (if appliable) and damage from the ground on all sides. Binoculars are acceptable where appropriate (non-critical areas). Areas of noticeable advanced deterioration will be accessed for hands-on inspection.
- A visual inspection is required for all bearing seat areas and the front faces of abutments and piers in the vicinity of bearings. If cracks, delaminations, scale or spalls are observed that potentially reduce the bearing area of any bearing, hands-on access will be required to accurately document dimensions (height, length, width, depth, etc.) of the observed deterioration.
- A visual inspection is required of the faces of pier caps in areas of high tension or shear stresses. If cracks, delaminations, spalls or other indications of overstressing are observed, hands-on access will be required to accurately document dimensions of the observed deterioration.
- Areas of cracks, scale, wetness, efflorescence or rust stains will be sounded with a hammer to determine the integrity of the concrete. Surrounding areas of scale and spalls will be sounded with a hammer to determine, if any; additional limits of delaminated or deteriorate concrete.
- Any exposed reinforcing will be cleaned of corrosion, if any. If section loss has initiated, the remaining diameter will be measured by calipers, or an estimated percentage of section loss will be noted. Weep holes will be inspected for clogs or blockages.
- Concrete protective coatings (oil-based, latex, epoxy, urethanes, etc.) will be inspected for bubbling/cracking/peeling and overall effectiveness.
- Where differential foundation movement (tipping or settlement) of an element is suspected, plumb bob/digital level measurements and joint opening or misalignment measurements will be taken. The location where measurements were taken will be clearly marked (with chisel and paint spot) so that measurements can be made in a similar manner at the same location during follow-up inspections (See Figure 5.8.1-1).
- Exposed concrete footings will be measured to show extent of exposure or undermining.
- Submerged surfaces of substructure elements will be inspected with waders if the water level is less than 2 feet deep, the water is clear enough for visual inspection, and stream flow velocities allow for safe inspection. See Section 7.4 Underwater Diving Inspection.
- All substructure elements in, or adjacent to, waterways will be checked for the presence of scour and undermining. Scour will be checked by probing around the entire base of every element exposed to potential scour. Areas that cannot be accessed with available equipment will be referred for underwater inspection.

    - ***<u>Special Note</u>****: After maximum local scour has occurred during peak flow periods, sediment may backfill the scour hole during low flow periods giving false indication to the inspector as to the actual extent of the scour problem. Probing through the soft surface sediment to the hard packed substrate with a probing rod will help to a limited degree.*

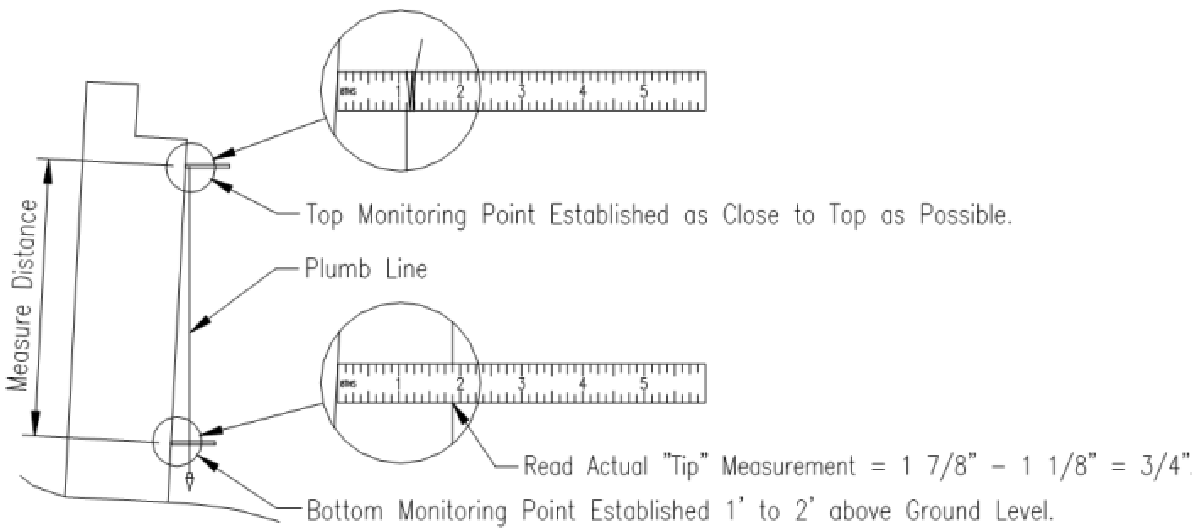


Figure 5.8-1 Recommended Method for Measuring Substructure Tipping Using a Plumb Line. ("Hold-Off" Method illustrated for use where face of substructure interferes with free movement of plumb bob.)

Documentation

- Field notes must be sufficient to be able to differentiate and divide the defect quantities among the four condition states for every element.
- A narrative description of defects found will be adequate when it is possible to fully describe them. Defects in condition states CS-3 and CS-4 will be described with location referencing a fixed, definable point and will include full defect dimensions (length, width, height, depth of loss, etc.).
- Sketches will be required if any of the following situations exist:
  - An individual substructure unit condition rating is "4" or less or a substructure has greater than 20% of its linear footage in condition state CS-3 or any CS-4.
  - There is 10% loss of bearing area or more due to spalls or scaling (or potential loss).
  - Scour resulting in undermining.
  - The defects found cannot be simply described as to size, orientation, and location.
  - Structural cracks (tension or shear cracks) are found in a pier cap.
- Cracks in reinforced concrete greater than 0.012 inch will be noted.
- Cracks in prestressed concrete greater than 0.004 inch will be noted.
- Concrete protective coatings will be documented for areas of peeling/bubbling/cracking and overall effectiveness.
- If stream scour condition exists that could influence the substructure at some time in the future, a reference will be made to conditions described under Channel & Channel Protection.
- Photographs will be taken of any defect causing a condition rating of "4" or less, and or condition state of CS-3 or CS-4.
- Photographs and/or explanations will also be provided when conditions warrant changing a condition rating or condition state from a previous inspection (either up or down).

Underwater/Probe and Wade Inspections

Inspection

- Inspect the substructure in accordance with BIRM Chapter 14, Sections 14.4-14.6.
- All substructure elements in, or adjacent to, waterways will be checked for the presence of scour and undermining. Scour will be checked by probing around the entire base of every element exposed to potential scour.
- Vertical, horizontal, transverse and/or longitudinal cracks will be measured for length and width. Cracking may be indications of settlement and/or scour.
- Look for abrasion typically at or below the water line, note any exposure of reinforcing and section remaining.
- Debris build-up or aggradation along substructure will be noted.

Documentation

- An aggregate of the above water and below water condition will be considered when evaluating the overall condition rating for B.C.03 – Substructure.
- Photographs will be taken of any defect causing a condition rating of "4" or less, and or condition state of CS-3 or CS-4.
- Photographs and/or explanations will also be provided when conditions warrant changing a rating number from a previous inspection (either up or down). Additional consideration will be added to include photographs of, but not limited to, inadequate waterways, ice jams or flows, debris, channel and structure alignment, and riprap conditions.
- Scour will be de documented with an elevation sketch when footings are exposed, showing locations of scour with reference to a fixed point on the affected substructure.

Damage Inspections

Inspection

- Inspection methods will vary depending on the type and severity of damage:
  - Concrete substructure elements damaged by environmental factors (e.g., Earthquakes, flooding) require widespread visual and physical examination for cracks, spalls, delaminations, settlement, and scour.
  - Concrete substructure elements damaged by impact damage requires concentrated visual and physical examination of the damaged element for cracks, spalls, delaminations, alignment, and scour.
- The damage inspection will be coordinated between the inspector, bridge owner, and any other relevant agencies to determine the scope of damage and planned inspection methods.

Documentation

- The inspection report will have thorough documentation, including height, length, width, depth, etc. of the condition of any concrete substructure element that has been damaged.
- Photographs of the damaged areas are required, and sketches are encouraged if text alone cannot easily convey the scope of the damage.
- As stated in Section 4.1.6 of this manual, damage inspections are typically used in the decision-making process for implementing or lifting emergency load posting restrictions or bridge closures.

5.8.1.2 Report Review

- Findings will be reviewed in accordance with the established Quality Control and Quality Assurance procedures.

- The inspection report reviewer will determine if the pattern, quantity or severity of the deteriorations found support the numerical condition ratings and condition states.
- Verify that critical defects (evidence of movement, presence of scour, structural cracks etc.) have been measured for comparison with previous measurements or that adequate monitoring points have been established. Progression of these defects may be cause for a lower condition rating and condition states and/or the need for stabilization work.
- Bridges with large or ongoing settlement/movement problems will be referred to the Soils and Foundations section for their review.
- Scour problems, other than simple run-off erosion, will be referred to the Hydraulics section for their review.

5.8.1.3 Maintenance Considerations

- Concrete deterioration is most commonly the result of a leaking deck joint or defective drainage system. The cause of the deterioration (joint or drainage) will always be repaired before, or in addition to, any recommended concrete repairs.
- Certain structural cracks may be repaired using chemical repair techniques. Engineering judgment and discussion with the Supervising Engineer are required for specific applications.
- Waterproofing methods can be the best way to prevent or slow the deterioration of reinforced concrete members. Care must be taken in the application of waterproofing systems to ensure that they are not applied in such a way as to prevent entrapped moisture in the concrete from exiting.
- A determination by an Engineer as to what is a structural repair and what is a "cosmetic" or non-essential repair, may help to limit repair quantities to a manageable level. Typically, spalls on massive concrete elements like abutments and solid shaft piers may not need repair if structural reinforcing steel is not exposed and aesthetics are not a concern.
- Repair of scour problems, other than simple run-off erosion, will not be proposed without discussion with the Hydraulics section.
- Addressing movement of substructure elements is normally beyond the scope of maintenance repairs and will require individual attention.
- When removing deteriorated concrete for repair of pier columns, generally the reinforcing steel will not be exposed for more than 6 ft. on one face at a time.

Figure 5.8-2 Tall Concrete Pier with Decorative Stone Masonry Facing

5.8.2 Masonry Substructures

Reference: BIRM Chapter 14

5.8.2.1 Inspection and Documentation Requirements

Initial/Inventory Inspections & Routine Inspections

Inspection

- Inspect the substructure in accordance with BIRM Section 7.5.6 and Sections 14.4-14.6.
- The entire stone masonry substructure will be inspected from a distance that is appropriate to identify and evaluate defects consistently and accurately for weather conditions, light conditions, defect type and severity.
- Problem areas with potential for CS-4 rating will be inspected hands-on to determine the extent of the deterioration or deficiency.
- Visually inspect the substructure elements for tilting, settlement, rotation, or other movement. If any of the following are noted, further investigation may be warranted:
    - Check to see if the substructure elements are plumb (Note: check to see if the design calls for a battered or sloped face).
    - Look to see whether or not the horizontal mortar joints appear parallel with the surface of the water if applicable.

- Look for abutment weepholes, if present, to see if they are clogged. A build-up of water behind the abutments can generate hydrostatic pressures that can cause lateral movement.
- Visually inspect abutments for signs of hydrostatic piping. This is caused when perforated drain pipes or weepholes become clogged, forcing water to seep through the embankment material, under the abutment footing, and discharge through the fill in front, possibly bringing with it sizable amounts of backfill material. Look for deep ruts in the fill in front of the abutment with possible exposure of the footing. The roadway or the approach slab may also show settlement.
- Visually sight along the faces of the substructure elements to try to detect displacement, tilting, settlement or other deformation.
- Look at the masonry stones for vertical splits through several courses of stone in the same general area.
- Evaluate the following items from the bearing, approach and joint inspections that may indirectly indicate substructure movement:
    - Gaps between the bearings and the pedestals.
    - Positioning of the bearing elements on the pedestals, (i.e. longitudinal or transverse misalignment) lack of full contact in the bearing area between the sole plate, bent or broken anchor bolts.
    - Vertical misalignment between the approach roadway slab and bridge deck. However, pavement expansion and approach fill expansion could conceivably cause vertical movement in the approach slab.
    - Gaps between the superstructure elements and abutment backwalls that are significantly greater or less than the design value or that expected for the ambient temperature.
    - If the superstructure end is in contact with the backwall, it may indicate that an abutment is moving.

o ***Special Note****: If movement of a substructure element occurs, the effects of that movement on bearings, joints, etc., may be visible at adjacent substructure elements, not at the element where the movement occurred. For example, over rotation of rocker bearings at a pier may be caused by movement of an adjacent abutment or pier with fixed bearings.*

- Probe areas where joint mortar is missing to determine the average depth of loss and the location of maximum loss.
- Stones with missing mortar below deck joints will be inspected for displacement, tilting, splitting, heaving, spalling, and crushing due to the freeze thaw effects of penetrating water.
- Check stones that have experienced splitting to determine whether or not the pieces are still in tight contact with the adjacent stones and still providing adequate stability to the substructure element.
- Look for signs of possible failure from crushing. Particular attention will be paid in the vicinity of bearings.
- All substructure elements, in or adjacent to waterways, will be checked for the presence of scour and undermining. Scour will be checked by wading and probing around the entire base of every element exposed to potential scour.

- Submerged surfaces of substructure elements will be inspected with waders if the water level is less than 2 ft deep, the water is clear enough for visual inspection, and stream flow velocities allow for safe inspection. Areas that cannot be accessed with available equipment will be referred for underwater inspection
  - ***Special Note****: After maximum local scour has occurred during peak flow periods, sediment may backfill the scour hole during low flow periods giving false indication to the inspector as to the actual extent of the scour problem. Probing through the soft surface sediment to the hard packed substrate with a probing rod will help to a limited degree.*

Documentation

- Field notes must be sufficient to be able to differentiate and divide the defect quantities among the four condition states for every element.
- A narrative description of defects found will be adequate when it is possible to fully describe them. Defects in condition states CS-3 and CS-4 will be described with location referencing a fixed, definable point and will include full defect dimensions (length, width, height, depth of loss, etc.).
- When deficiencies cannot be easily described, the condition rating is a "4" or less, or more than 20% of the substructure is in condition state CS-3 or CS-4, elevation drawings will be provided of the substructure elements to show deteriorations noted. Sectional views and detailed drawings will be provided, if necessary, to adequately describe the extent of noted deficiencies.
- Document areas of water staining and deterioration due to water leakage from deck joints.
- Document all scour as well as areas of exposed footings and undermining of the substructure elements. Depths of scour holes will be measured utilizing probing rods, survey rods, sonic equipment or other measuring device and the presence of any backfilled sediment will be noted.
- Document any impact damage on the substructure elements due to ice, debris and marine or vehicular traffic.
- Document any signs of crushing or splitting of the stones in the area of bearings.
- Notes will be made describing the current condition of all previously noted problems so that a rate of deterioration can be established for monitoring purposes. If the condition rating has changed from the previous inspection due to increased movement or quantity or size of deterioration or if a deteriorated area has been repaired, photographs, documentation and an explanation of why the condition rating has changed will accompany the inspection report.
- Photographs will be taken of any defect causing a condition rating of "4" or less, and or condition state of CS-3 or CS-4.

Underwater/Probe and Wade Inspections

Inspection

- Inspect the substructure in accordance with BIRM Chapter 14, Section 14.4-6.
- All substructure elements in, or adjacent to, waterways will be checked for the presence of scour and undermining. Scour will be checked by probing around the entire base of every element exposed to potential scour.
- Split stones, spalls and masonry displacement defect dimensions will be measured. Defects may be indications of settlement and/or scour.
- Look for abrasion typically at or below the water line, note any exposure of reinforcing and section remaining.
- Debris build-up or aggradation along substructure will be noted.

Documentation

- An aggregate of the above water and below water condition will be considered when evaluating the overall condition rating for B.C.03 – Substructure.
- Photographs will be taken of any defect causing a condition rating of "4" or less, and or condition state of CS-3 or CS-4.
- Photographs and/or explanations will also be provided when conditions warrant changing a rating number from a previous inspection (either up or down). Additional consideration will be added to include photographs of, but not limited to, inadequate waterways, ice jams or flows, debris, Channel and Structure alignment, and riprap conditions.
- Scour will be de documented with cross sections when footings are exposed or undermined, showing locations of scour with reference to a fixed point on the affected substructure. An elevation sketch may also be necessary to describe scour conditions.

Damage Inspections

Inspection

- Inspection methods will vary depending on the type and severity of damage:
    - Masonry substructure elements damaged by environmental factors (e.g., earthquakes, flooding etc.) require widespread visual and physical examination for splits, spalls, displacement, settlement, and scour.
    - Masonry substructure elements damaged by impact require concentrated visual and physical examination of the damaged element for splits, spalls, displacement, and alignment.
- The damage inspection will be coordinated between the inspector, bridge owner, and any other relevant agencies to determine the scope of damage and planned inspection methods.

Documentation

- The inspection report will have thorough documentation, including height, length, width, depth, etc. of the condition of any masonry substructure element that has been damaged.
- Photographs of the damaged areas are required, and sketches are encouraged if text alone cannot easily convey the scope of the damage.
- As stated in Section 4.1.6 of this manual, damage inspections are typically used in the decision-making process for implementing or lifting emergency load posting restrictions or bridge closures.
- Document any impact damage on the substructure elements due to ice, debris and marine or vehicular traffic.
- Review the inspection findings in accordance with established Quality Control and Quality Assurance procedures.
- Cross reference the inspection report, inspection field notes and photographs to ensure they are mutually supportive of their documentation.
- Review the inspection field notes for signs of tilting, displacement, settlement or rotation of any substructure elements. The reviewer will also check for signs of contraction and local scour around substructure elements. If either of these conditions are noted for the first time, or if additional movement or scour is noted from the previous inspection, or if movement or scour is having serious adverse effects on the stability of the substructure element, the reviewer will make recommendations to correct the observed deficiencies.

- Review the inspection field notes for signs of crushing of the substructure stones particularly in the area of bearings that may indicate the stone is being over stressed. If crushing is noted for the first time or if additional crushing is noted from the previous inspection, the reviewer will investigate the need for a revised load rating or make recommendations to correct the observed deficiencies.
- Low condition ratings or condition states that are caused by extensive or widespread deterioration will be reasons to request supplemental testing or analysis to better determine the condition and stability of the substructure element and whether rehabilitation or replacement is warranted.
- The inspection reviewer will determine if patterns of deterioration or progressive deterioration are taking place. Progression will be determined by comparing present to past inspection reports.
- The sudden or progressive appearance of cracks or movements in the substructure stones may indicate the need for a new load analysis and/or weight restriction of the bridge structure.

5.8.2.2 Maintenance Considerations

- The purpose of joint mortar, when incorporated into the design, is to furnish a cushion for the stones that helps to distribute the pressure uniformly across the stone surface. It also relieves the stone of transverse stresses and concentrated crushing pressures to which the projecting points are subjected when in contact with other stones. Therefore, loss of joint mortar can increase the stresses in the stone to the point where crushing or splitting may occur. Lost joint mortar will be replaced with an approved material utilizing approved procedures.
- Stone masonry set without mortar (dry laid) does not need to have joints mortared as a maintenance repair. In some cases, to do so may make the situation worse. For example, by preventing water from draining through an abutment, a build-up of hydrostatic pressure behind the abutment may cause tipping.
- Splits in stone, joint mortar breakdown and openings in joints provide access to water seepage that can further deteriorate the stone or mortar joint through freeze/thaw action. Splits and open joints will be considered for sealing, injection or other repair depending on their location and severity. Only splits that are allowing water to enter will be sealed. Splits or mortar breakdown that is allowing water from behind the abutment to exit will not be sealed unless it is determined that this is causing a larger problem. Engineering judgment and discussion is required prior to conducting repair work in order to determine the extent and criticality of the problem, effects on public safety and cost/benefit ratio of the repair.
- Settlement or tipping of substructure elements may be caused by erosion of the foundation material caused by scour. If the waterway at the bridge site has a history of scour problems, consideration will be given to the design and construction of waterway protection devices such as rip rap, gabions, cofferdams, check dams, etc., to reduce the adverse effects of scour. However, if the bridge is a movable bridge or if a traffic intersection is located at one end of the bridge, movement of the substructure elements may occur due to the longitudinal forces induced by vehicles decelerating and stopping for bridge openings and traffic signals.
- If the substructure elements are regularly impacted by ice and debris, consideration will be given to the design and construction of protection devices to divert or absorb the impact forces. This will have a secondary benefit of moving waterway blockages and turbulence away from the substructure elements. However, this will also require a hydraulic analysis to be sure the hydraulic capacity of the structure is not reduced appreciably.
- All substructure impact protection devices (guardrail, fender system, ice breaker, etc.) will be routinely checked to ensure that adequate protection is maintained. All damaged protection devices will be repaired in a timely manner to maintain the integrity of the system.

Figure 5.8-3 Tall Stone Masonry Bridge Abutment with Newer Concrete Wingwall Added.

5.8.3 Timber Substructures

References: BIRM Chapter 14
USDA Forest Service Publication "Timber Bridges: Design, Construction, Inspection and Maintenance”
MDT Timber Bridge Inspection Guide
MDT Timber Element Condition State Guide

5.8.3.1 Inspection Requirements

Initial/Inventory Inspections & Routine Inspections

Inspection

- Inspect the timber substructure elements in accordance with BIRM Section 7.4.7 and Sections 14.4-14.6 and the MDT Timber Bridge Inspection Guide.
- The entire substructure will be inspected from a distance that is appropriate to identify and evaluate defects consistently and accurately for weather conditions, light conditions, defect type and severity.
- Areas that appear to have advanced deterioration or signs of stress in critical areas during the visual inspection will be inspected hands-on to determine the type and extent of deterioration or deficiency.
- Check timber members for signs of crushing at timber pile/concrete footing interface (if exposed), pile/bent cap interface, or other bearing areas. Look for buckling, cracking, crushing and other signs of over stress along the length of axially loaded piles and in areas of maximum bending stress on pier bent caps.
- Check for signs of decay and parasite damage of timber piles in areas frequently exposed to wetting/drying cycles. Deterioration may also occur at locations of connections where the paint or preservative system has been damaged or disrupted. Areas that have evidence of serious

deterioration, decay or infestation will be considered for further investigation by Nondestructive Testing or Destructive Testing methods (such as Incremental or Resistograph Boring).

- A representative sample of the timber surface area showing no surface deterioration will be hammer tapped or probed with an ice pick in an attempt to locate internal deterioration. If deterioration is found, additional probing will be performed. Be careful of frozen timber that may have internal deterioration but sounds solid due to water frozen in the internal cavities.
- If timber piles on bridges have been repaired using steel or FRP jacket wraps filled with concrete or epoxy. The FRP jacket wraps will be inspected for cracking and deformations.
- Visually inspect the substructure elements for tilting, settlement, rotation or other movement.

    o ***Special Note****: If movement of a substructure element occurs, the effects of that movement on bearings, joints, etc., may be visible at adjacent substructure elements, not at the element where the movement occurred. For example, over rotation of rocker bearings at a pier may be caused by movement of an adjacent abutment or pier with fixed bearings.*

- Note all fire damaged areas and whether or not the damage is superficial (scorched) or if loss of effective section has occurred. Note the depth of char.
- Check for shear cracks parallel to the longitudinal axis of piles and pier caps. If there are any glue-laminated members (pier caps), look for shear cracks between the laminas. For bending members, horizontal shear cracks will cause the member to split and act as two smaller members, independent of each other. Therefore, horizontal cracks and delaminations at mid-height of the member are more critical than those nearer the top or bottom surface.
- Secondary bracing members may be constructed of timber or steel members. For timber, check for deterioration, proper fit, cracked or split members and corroded, loose or missing fasteners. For steel members, check for section loss, loose or missing fasteners and bowing or buckling of the member.
- Timber members are best connected with seated, bearing type connections. Check bolted, framed, or nailed connections for member deterioration or connection failure.
- Check bent caps for excessive deflection, sagging and vibration as well as for proper alignment.
- All substructure elements, in or adjacent to waterways, will be checked for the presence of scour and undermining. Scour will be checked by wading and probing around the entire base of every element for signs of contraction or local scour.
- Submerged surfaces of substructure elements will be inspected with waders if the water level is less than 2 ft deep, the water is clear enough for visual inspection, and stream flow velocities allow for safe inspection. Areas that cannot be accessed with available equipment will be referred for underwater inspection

    Special Note*: After maximum local scour has occurred during peak flow periods, sediment may backfill the scour hole during low flow periods giving false indication to the inspector as to the actual extent of the scour problem. Probing through the soft surface sediment to the hard packed substrate with a probing rod will help to a limited degree*.

Documentation

- Field notes must be sufficient to be able to differentiate and divide the defect quantities among the four condition states for every element.
- A narrative description of defects found will be adequate when it is possible to fully describe them. Defects in condition states CS-3 and CS-4 will be described with location referencing a fixed, definable point and will include full defect dimensions (length, width, height, depth of loss, etc.).

- When deficiencies cannot be easily described, the condition rating is a "4" or less, or more than 20% of the substructure is in condition state CS-3 or CS-4, elevation drawings will be provided of the substructure elements to show the layout of the timber substructure and deterioration noted. Sectional views and detailed drawings will be provided, if necessary, to adequately describe the extent of noted deficiencies.
- Document deterioration such as debris build-up, fungus growth, parasite infestation, fire damage, weathering and warping, crushing, splitting, cracking, checking, chemical damage and signs of overstress. All deteriorations noted will include their size and relative location on the member. Where possible, measurements will be taken to determine the remaining effective section on the member.
- Document horizontal cracks, splits, or delaminations in bending members. Note whether or not the cracks, splits, or delaminations pass entirely or partially through the member and measure the depth of the crack, if possible. Dimension the height of the member halves above and below the crack, the member width and the amount the crack has opened.
- Document signs of substructure settlement, tilting or other misalignment and whether or not adverse effects on the superstructure elements were noted.
- Document areas of water staining and deterioration due to water leakage from deck joints.
- Document conditions of contraction and local scour. Depths of scour holes and the presence of backfilled sediment will be noted.
- Document impact damage on the substructure elements due to ice, debris and marine or vehicular traffic.
- Particular care will be given to documenting any increased quantity or size of deteriorations that have changed since the last inspection. If the condition rating has changed since the last inspection, a photograph and explanation of why the rating has changed will accompany the inspection report.
- Notes will be made describing the current condition of all previously noted problems so a rate of deterioration can be established for monitoring purposes.
- Typical conditions and deteriorations causing a condition rating of less than or equal to "4" or condition states CS-3 or CS-4 will be photographed.
- Jacketed Timber Piles (steel or FRP) will be documented and quantified.

Underwater/Probe and Wade Inspections

Inspection

- Inspect the timber substructure in accordance with BIRM Section 7.4.7 and Sections 14.4-6.
- All substructure elements in, or adjacent to, waterways will be checked for the presence of scour and undermining. Scour will be checked by probing around the entire base of every element exposed to potential scour.
- Check for signs of decay and parasite damage of timber piles in areas frequently exposed to wetting/drying cycles. Deterioration may also occur at locations of connections where the paint or preservative system has been damaged or disrupted. Areas that have evidence of serious deterioration, decay or infestation will be considered for further investigation by Nondestructive Testing or Destructive Testing methods (such as Incremental or Resistograph Boring).
- Look for abrasion typically at or below the water line.
- Debris build-up or aggradation along substructure will be noted.

Documentation

- An aggregate of the above water and below water condition will be considered when evaluating the overall condition rating for B.C.03 – Substructure.
- Photographs will be taken of any defect causing a condition rating of "4" or less, and or condition state of CS-3 or CS-4.
- Photographs and/or explanations will also be provided when conditions warrant changing a rating number from a previous inspection (either up or down). Additional consideration will be added to include photographs of, but not limited to, inadequate waterways, ice jams or flows, debris, Channel and Structure alignment, and riprap conditions.
- Scour will be de documented with an elevation sketch when footings are exposed or undermined, showing locations of scour with reference to a fixed point on the affected substructure.

Damage Inspections

Inspection

- Inspection methods will vary depending on the type and severity of damage:
    - Timber substructure elements damaged by environmental factors (e.g., earthquakes, flooding etc.) require widespread visual and physical examination for splits, cracks, breaks, alignment, displacement, settlement, and scour. Connections will be inspected and will be in place and functioning as intended.
    - Note all fire damaged areas and whether or not the damage is superficial (scorched) or if loss of effective section has occurred. Note the depth of char.
    - Timber substructure elements damaged by impact damage requires concentrated visual and physical examination of the damaged element for splits, cracks, breaks, alignment, displacement, and settlement.
- The damage inspection will be coordinated between the inspector, bridge owner, and any other relevant agencies to determine the scope of damage and planned inspection methods.

Documentation

- The inspection report will have thorough documentation, including height, length, width, depth, etc. of the condition of any timber substructure element that has been damaged.
- Photographs of the damaged areas are required, and sketches are encouraged if text alone cannot easily convey the scope of the damage.
- As stated in Section 4.1.6 of this manual, damage inspections are typically used in the decision-making process for implementing or lifting emergency load posting restrictions or bridge closures.
- Document any impact damage on the substructure elements due to ice, debris and marine or vehicular traffic.

5.8.3.2 Report Review

- Review the inspection findings in accordance with established Quality Control and Quality Assurance procedures.
- Cross reference the inspection report, inspection field notes and photographs to ensure they are mutually supportive of their documentation.

- The inspection reviewer will determine if a pattern of deterioration or progressive deterioration is taking place. Progression will be determined by comparing past and present inspection reports.
- Review the inspection field notes for signs of tilting, settlement or scour, splitting, cracking or impact damage. Determine if conditions require additional analysis or immediate repair.
- Low condition ratings that are caused by extensive or widespread deterioration will be reasons to request supplemental nondestructive or destructive testing or analysis to better determine the condition and stability of the substructure element, and whether rehabilitation or replacement is warranted.

5.8.3.3 Maintenance Considerations

- The most common type of preventive maintenance for wood structures is the application of preservative treatment, paint or other protective coatings to protect the timber from fungus or parasites and the elements. Preservative treatment or paint will be applied as required to protect the timber elements. It will be noted that preservative treatments typically do not penetrate through the entire cross-section of the member. Therefore, as with non-treated or painted members, interior deterioration due to parasite infestation may still occur despite the solid appearance of the exterior.
- Loose connections may occur due to timber shrinkage, cracking, checking, decay or crushing around the connector or deterioration of the fastener itself. Loose fasteners will be tightened, and broken, missing or deteriorated fasteners (exhibiting greater than 20% section loss) will be replaced.
- Remove debris to avoid moisture accumulation.
- Cut vegetation from around wet areas and areas prone to debris buildup to allow better air circulation for drying action.
- If the substructure elements have been properly designed and show little deterioration, movement of substructure elements may likely be caused by scour. If substructure elements at a particular bridge site have a history of, or high susceptibility to the effects of contraction and local scour, consideration will be given to the design and construction of waterway protection devices such as rip rap, gabions, cofferdams, check dams, etc., to reduce the adverse effects of scour.
- If the substructure elements are regularly impacted by ice and debris, consideration will be given to the design and construction of protection devices to divert or absorb the impact forces. This will have a secondary benefit of reducing waterway blockages and turbulence around the substructure elements.
- Substructure impact protection devices (guardrail, fenders, dolphins, ice breakers, etc.) will be routinely checked to ensure adequate protection is maintained. All damaged protection devices will be repaired to maintain the integrity of the system.

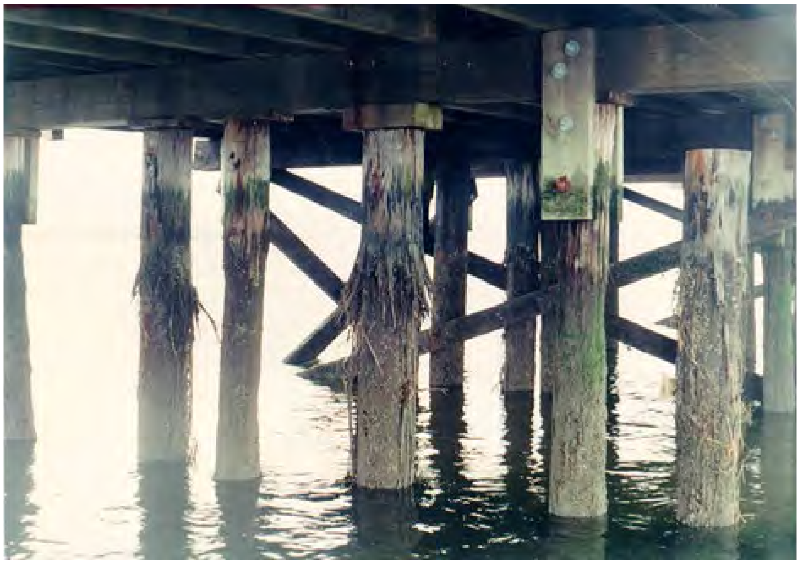


Figure 5.8-4 Timber Pile Bent exhibiting Freeze-Thaw Damage above the waterline. Also examples of shims, blocking and splices between the piles and pile cap.

5.9 Waterway Inspection

5.9.1 Channel and Channel Protection

The purpose of this section is to describe inspection and documentation methods and procedures for assessing the stability and capacity of a channel under the bridge as well as the effectiveness of any channel or substructure protection provided. This resulting documentation will assist in coding ADE Item 900 – Scour and 901 – Scour Countermeasures as well as the following Federal coding items:

- Item B.C.09 – Channel Condition Rating
- Item B.C.10 – Channel Protection Condition Rating
- Item B.C.11 – Scour Condition Rating

It will also provide information for Federal coding of Items B.N.02 - B.N.06 (Vertical Clearances, Channel Width, Horizontal Clearances and Substructure Navigation Protection.) when the waterway is navigable.

Chapter 7 has supplemental information and requirements for Underwater Inspection and Probe and Wade Inspections, as well as channel terminology and types and causes of scour.

Scour Appraisals

Each bridge in Montana over a waterway will have a Scour Analysis/Appraisal. The Multimedia tab in the BrM Hydraulics folder will contain a Scour Analysis/Appraisal, if one has been done.

If conditions found in the field do not appear to correlate with the sketches in the Federal Specifications for this item, then the inspector will suggest a re-evaluation of the existing scour appraisal or request an initial scour appraisal be performed, if none exists. The request will be in the form of an Email sent to MDT Bridge Management HQ.

Reference: BIRM Chapter 16.1

5.9.1.1 Inspection and Documentation Requirements

Initial/Inventory Inspections & Routine Inspections

Pre-Inspection review, preparation and planning are discussed in Section 9.2; however, for channels and waterways it is advisable to obtain as-builts (showing foundation details) and previous cycles of cross-section or bathymetric survey measurements and/or historic information on the channel shape and possible lateral migration. Aerial photos could also reveal this. If it is a navigable waterway (permit required), the plans will also show the minimum vertical and lateral clearances. Plans can also be used to help in calculating the hydraulic opening available.

Inspection

- Inspect the channel and all channel protection devices in accordance with BIRM section 16.1.
- All riprap, gabions, spurs, spur dikes and other types of channel and flood plain protection devices will be inspected for signs of joint separation, broken or deteriorated retention cages, missing or displaced stones, cracked, spalled or deteriorated concrete, impact damage, erosion, loss or lack of vegetated cover, tilting, displacement and other deterioration.
- If the channel is navigable per Item B.N.01, protection devices such as timber, rubber, concrete or steel fender systems, dolphins, protective islands, etc., will be inspected for defects or impact damage and evaluated as to their effectiveness in providing adequate impact protection to the bridge structure from marine vessels. Navigation guidance systems (signs, lights, etc.) will be inspected for deteriorated or broken devices.
- Visually evaluate the overall effectiveness of the channel protection devices at redirecting or absorbing the energy of the water flow by estimating the flow velocity (fast or slow) and observing the flow characteristics (calm, turbulent, swirling, above normal flow depths, etc.), upstream, downstream and through the hydraulic opening.
- Look at all rigid protection devices in the channel such as gabions and concrete walls, for signs of local or contraction scour. Inspect non-rigid protection devices such as riprap or earthen dikes, for local scour of the base material (look for sloughing of the construction material) or erosion of the construction material itself.
- Probe all areas of suspected scour to determine the limits of scour.

> *The problem of accurately determining maximum local scour and rate of change of local scour over time is one of the most difficult aspects of bridge inspection, yet it is one of the most important aspects of evaluating bridge safety. In order to effectively evaluate the scour potential of a structure, it is recommended to look back multiple inspection cycles for evidence of general and contraction scour and any lateral movement of the waterway so that a clearer picture of the extent and rate of scour development can be seen. This is essential to plan the proper maintenance efforts required to arrest current or potential scour damage.*
>
> ***Special Note:*** *After maximum local scour has occurred during peak flow periods, sediment may backfill the scour hole during low flow periods giving false indication to the inspector as to the actual extent of the scour problem. Probing through the soft surface sediment to the hard packed substrate with a probing rod will help to determine actual scour depth.*

- Look for irregularities in the surface slope of the protective devices (dips, depressions, sink holes, etc.), which can be a first indication of erosion or scour of the base material.

- Observe the channel for signs of general scour (degradation) and aggradation.
- Look at the banks of the channel for signs of erosion and sloughing of the bank material or vegetation.
- Site the main channel for misalignment with the bridge substructure elements. If misalignment is observed, estimate the degree of misalignment.
- Look in the channel for debris accumulation from ice, vegetation, etc., that constricts the water flow through the hydraulic opening. This accumulation may accelerate contraction or local scour, due to increased water flow velocity and development of water vortices.
- Look at the channel for signs of lateral movement since previous inspections.

Documentation

- Channel notes will be located in BrM as follows:
    - Channel defects that do not affect the substructure will be documented in the Probe and Wade notes of BrM.
    - Channel defects that directly affect the substructure, such as scour exposing a footing that will be covered by channel material, will be documented at ADE 900 – Scour. A quantity of (1) each will be used for every affected substructure unit.
    - Scour Countermeasures and any associated defects will be noted at ADE 901 – Scour Countermeasures.
- Document defects found in the channel protection devices. A channel sketch showing the defects will be provided when the channel is rated 4 or less.
- Record the general flow characteristics of the channel (fast, slow, high, low, turbulent, etc.), at the time of inspection.
- Record the direction and distribution of the flow between piers and between piers and abutments. For example, which span has the main flow, is the flow impacting the substructure at an angle, is debris causing the flow velocity to increase along a substructure.
- Document all conditions of general, contraction and local scour as well as any signs of undermining of the protective device elements.
- Excessive scour conditions and any undermining conditions causing a safety concern requiring immediate action will be reported as a Critical Finding.
- Depths of all scour holes will be measured utilizing probing rods, survey rods, drop lines or sonic equipment and the presence of any backfilled sediment will be noted. Depths will be documented relative to the natural mudline (average channel bottom), not from the surface of the water.
- Document accumulation of any ice, debris, vegetation, etc., which constricts or disrupts the water flow through the hydraulic opening or around the protection devices.
- Document the presence of sediment buildup immediately downstream of the bridge structure that may indicate the presence of contraction scour.

Underwater (Dive) Inspections

Inspection

- Underwater (Dive) inspections will only be required when portions of the substructure are in the waterway and cannot be inspected by wading year-round. If a bridge is not scheduled for an underwater inspection and requires an underwater inspection, do not change the underwater inspection requirements in BrM. Contact the underwater inspection term contract manager to have the bridge added to the underwater list.

- If the high-water conditions are temporary in nature, then it may be possible to perform a "Follow-up" Probe and Wade inspection, in lieu of requesting an Underwater Inspection.
- If the anniversary date for inspection is typically during times of seasonal high water, consider shifting the anniversary date for the inspection to a time of seasonally low water, if possible.
- Inspect the channel and channel protection in accordance with BIRM Section 16.2
- Inspect per the Underwater Inspection requirements in Chapter 7.

Documentation

- Document per the Underwater Inspection requirements in Chapter 7 and also per the above.

Damage Inspections

Inspection

- Inspect the channel and all channel protection devices in accordance with BIRM section 16.1.7.
- Inspection methods will vary depending on the type and severity of damage.
- Channel and channel protection elements damaged by environmental factors (e.g., earthquakes, flooding etc.) require widespread visual and physical inspection for defects such as undermining, settlement, debris blockages, scour and failure.
- The damage inspection will be coordinated between the Team Leader, bridge owner, and any other relevant agencies to determine the scope of damage and planned inspection methods.

Documentation

- The inspection report will have thorough documentation, including height, length, width, depth, etc. of the condition of any channel or channel protection element that has been damaged.
- Photographs of the damaged areas are required, and sketches are encouraged if text and photos cannot easily convey the scope of the damage.
- Damage inspections may be used in the decision-making process for implementing or lifting emergency load posting restrictions or bridge closures.
- Document any impact damage on the channel and channel protection elements due to ice, debris and marine or vehicular traffic.

5.9.1.2 Report Review

- Review the inspection findings in accordance with established quality control and quality assurance procedures.
- Cross reference the inspection report, inspection field notes, and photographs to ensure they are mutually supportive of their documentation.
- If excessive debris build-up or degradation of the channel is noted, check to see if any adverse effects due to scour were noted in the substructure section of the report.
- Review the inspection report for signs that a pattern of deterioration or progressive deterioration is occurring in the channel or with the channel protection devices. Progression will be determined by comparing present and past inspection reports.
- If the reviewer feels there is progressive scour that could impact the substructure, such as scour exposing a footing, and/or the inspector suggests an initial scour evaluation or reevaluation, then the reviewer will forward a request for this to the Bridge Maintenance Engineer, who will forward to MDT Hydraulics, if appropriate. See 5.9.1 above for examples.

5.9.1.3 Maintenance Considerations

- The inspector will only perform minor maintenance that will facilitate better access and/or allow better visual evaluation of an element, such as:
  - Removing small debris accumulation
- Limit Work Candidates/Repair Suggestions to items that can generally be performed by in-house MDT Maintenance forces, such as:
  - Removing excessive aggradation to facilitate streamflow.
  - Adding minor amounts of riprap to protect the substructure.

Figure 5.9-1 Timber Fender System with Navigation Lights.

Figure 5.9-2 Sand Bar and Vegetation Growth in the Channel.

5.10 Culverts

Reference: BIRM Chapter 15

5.10.1 Inspection Requirements

Initial/Inventory Inspections and Routine Inspections

Inspection – Approach Roadway and Embankment

- Inspect Roadways and Embankments in accordance with BIRM Section 15.5.9
- Inspect the roadway for settlement due to culvert flattening, for evidence that the roadway has been patched or otherwise built-up, for cracks running parallel to the culvert centerline and for signs of erosion or failure of the side slope over the culvert. Look for signs of sink holes over the culvert that may be due to exfiltration of the fill material through joints in the culvert.
- Evaluate the approach willer profile-and safety features such as guardrails. **These observations will not affect the condition code of the culvert but** will be included in the inspection report.
- Inspect the approach embankments for any conditions that might affect negatively impact the culvert (heavy embankment erosion near barrel ends, trees growing along the embankment whose roots may damage the culvert, etc.).

Inspection – Waterway

- Inspect the waterway in accordance with Section 5.9 and Chapter 7.
- Check for changes in stream/culvert horizontal or vertical alignment that might affect the hydraulic adequacy of the culvert or cause scour. Note whether or not the stream bed fluctuates between high and low flow volumes. For example, when looking at the previous report photos, has the amount of channel bed material along the bottom of the culvert changed (culvert bottom was bare previously but is now covered in 6” of bed material). If deposition or removal of stream bed material is apparent, consideration could be given to taking measurement(s) from the channel bed to culvert ceiling at repeatable points within the culvert barrel(s).
- Check for changes in the ground cover or land use that might change the volume of water the culvert must pass within the line of sight while looking upstream and downstream from the culvert inlet/outlet. If the channel bends in the vicinity of the bridge, check upstream/downstream from the bend(s).
- Check for any debris buildup or other obstructions in the waterway upstream and downstream from the culvert and any effects the obstruction is having on the hydraulic adequacy. Check the inlet and outlet for evidence of piping (water flowing under/around, instead of through the pipe).

Inspection – Culvert Barrel and End Treatments

- Inspect in accordance with BIRM Section 15.5
- General:
    - Check the culvert headwall, wingwalls, and end treatments for any material deficiencies/deterioration, undermining, scour, piping, tipping and settlement.
    - Check for any separation and/or misalignment of the culvert at junctions with the headwalls and/or aprons.
    - In general terms, inspect the level of channel bed material inside of the culvert (i.e., is it consistent throughout the barrels, are there isolated heavy deposits, is there channel bed material along just one side of the barrel, etc.).

- Concrete:
    - Check the culvert barrel, cut-off wall, and end treatments for material deficiencies such as spalling, exposed rebar, cracking, scaling/abrasion, delaminations, efflorescence, etc.
    - Check for signs of distress/structural cracking (e.g., cracks along the centerline of the barrel roof).
    - Check the culvert barrel for vertical and lateral misalignment along the joints between adjacent precast sections. Also check these joints for differential opening (e.g., wider at the top than bottom).
    - Check for backfill material and/or water passing through the joints between adjacent precast sections.
    - Check any weep holes for functionality/clogging.
- Metal:
    - Check the culvert barrel and end treatments for corrosion and section loss. Section loss on the fill side of the pipe is difficult to detect unless there are visible perforations, so randomly tap the culvert surfaces with a hammer/rod to detect denting which may indicate section loss. Keep in mind that while aluminum does not rust, it can exhibit section loss due to the pH level of backfill material and runoff with fertilizer.
    - Intermittently tapping the culvert floor with a hammer or rod will also help detect voids below the pipe floor (possible indication piping or water flowing below the pipe).
    - Check the culvert barrel for deformation. Deformation may be flattening, peaking, creasing, tears or dents due to settlement, loads over time, construction, flood debris, or rocks below the culvert that have slowly deformed the floor. General gradual deformation like settlement may be difficult to quantify, so the inspector may have to quantify this using general terms (e.g., “minor settlement”). Other deformations can be more easily quantified by taking measurements at these locations and also at control points (areas with no visible deformation) between bolt lines, across the spring lines or from floor to ceiling if there is no debris to skew the measurements.
    - Check for cracking in the metal. This are more likely to be found along bolt lines for pipes constructed from several plates. Cracks are also seen at areas of heavy section loss.
    - Check for gaps/separation of the pipe culvert and headwalls. Also check for separations at pipe joints.

Inspection – Aprons, Energy Dissipaters, and Flumes

- Inspect in accordance with BIRM Section 15.5.
- Check the apron, which reduces erosion at the inlet and outlet (typically a concrete slab or riprap), for deterioration, missing stones, undermining of slab, movement of stones due to scour and deterioration of the joint between the apron slab and headwall. Deterioration of this allows leakage of water to the soil behind the headwall.
- Check the energy dissipaters, which reduce out flow velocity and downstream erosion (typically rip-rap or concrete basin), for missing stones, movement of stones, scour, undermining, deterioration of the basin and overall effectiveness of the dissipater.
- Check the flumes (typically concrete, bituminous material or riprap) for deterioration, erosion, debris and signs of water bypass.

Documentation

- Since there are typically no topside NBEs, BMEs or ADEs for culverts under fill, any significant topside deterioration notes will be placed in the General Notes section of SMS, especially if deteriorations necessitate the generation of a work item (e.g., willer erosion that makes guardrail unstable).
- Document culvert deficiencies. Widespread defects can be discussed using general terms (e.g., the culvert walls have surface rust throughout, +/-50% of surface area). Otherwise, defect dimensions will include length, width, height, depth of loss, orientation and location relative to a fixed, easily identifiable point.
- Deformation documentation will include repeatable monitoring measurements at the defect, as well as similar measurements taken at a control point where there is no deformation. This will give the scale of the deformation.
- Document the channel condition in accordance with Section 5.9 and Chapter 7.

Underwater (Dive) Inspections

Inspection

- Inspect the channel in accordance with MDT BIM Section 5.9, MDT BIM Chapter 7, and Federal BIRM Chapter 16.2
- Inspect areas of the culvert not accessible via wading, as noted in inspection procedures above for typical biennial inspections (not underwater).

Documentation

- Document the condition of underwater elements using the same procedures as noted in the documentation procedures above for typical biennial inspections (not underwater).
- Document the channel condition in accordance with Section 5.9 and Chapter 7.

Damage Inspections

Inspection

- Inspection methods will vary depending on the type and severity of damage:
    - Culvert elements damaged by environmental factors (e.g., earthquakes, flooding) require widespread visual and physical inspection for defects including, but not limited to displacement, settlement, scour, piping, and debris blockages. Additional defects will be inspected for based on the culvert type.
    - Culvert elements damaged by impact require a concentrated visual and physical inspection based on the element type damaged.
- The damage inspection will be coordinated between the inspector, bridge owner, and any other relevant agencies to determine the scope of damage and planned inspection methods.

Documentation

- The inspection report will have thorough documentation, including height, length, width, depth, etc. of the condition of any element that has been damaged.
- Photographs of the damaged areas are required, and sketches are encouraged if text alone cannot easily convey the scope of the damage.
- Document any impact damage on elements due to ice, debris and marine or vehicular traffic.

5.10.2 Report Review

- Review the inspection findings in accordance with established Quality Control and Quality Assurance procedures.
- Cross reference the inspection report, inspection field notes and photographs to ensure they are mutually supportive of their documentation.
- The inspection reviewer will determine if a pattern of deterioration or progressive deterioration is taking place. Progression will be determined by comparing present and past inspection reports.
- Special attention will be given to field note documentation indicating changes in the culvert shape, the presence of scour, piping or other problem that may warrant further investigation.
- Culverts are usually designed to use the vertical and horizontal earth pressures to maintain their stability and increase their live load capacity. Therefore, any change in the "As-Built" condition of the soil surrounding the culvert (addition or removal) will be noted and possibly analyzed for effects on the stability and capacity of the culvert.
- Changes which increase or decrease the depth, velocity or flow direction of the waterway, will be assessed in terms of how they may affect the long-term waterway stability (e.g., lateral movement, aggradation, degradation, etc.) and hydraulic adequacy of the culvert.

5.10.3 Maintenance Considerations

- By the nature of their construction, culverts often constrict the flow of water in the waterway. This constriction increases the potential for waterway blockage with debris and sediment, and increases the probability of scour around the culvert especially if high outlet velocity or high inlet turbulence exist. Therefore, any blockages noted will be removed as soon as possible (during the inspection if possible).
- Culverts typically have steep approach embankments, as well as large, abrupt drop-offs at the culvert crossings. Headwalls and wingwalls may be exposed to traffic presenting collision hazards to passing vehicles. Routine maintenance will include safety considerations (e.g., guardrails) as well as structural and hydraulic considerations.
- The addition of cut-off walls will be considered where "piping" or seepage around the outside of the culvert structure is found or suspected.
- Severely deteriorated culverts may be reviewed for repair by relining the culvert barrel.
- Significant debris will be removed in the vicinity of the bridge and inside the barrels.

Figure 5.10-1 Cast-In-Place Concrete Culvert with Erosion at the Outlet.

5.11 Inspection Manuals, Equipment and Tools

It is important that bridge inspectors have the tools necessary to conduct a thorough inspection. A successful bridge inspection program is dependent upon proper use of reference materials, equipment and tools.

5.11.1 Required Manuals

Inspectors will have access to the following manuals or books while in the field provide assistance in the inspection of structures:

1. MDT Bridge Inspection Manual
2. Bridge Inspection Techniques for NSTMs handbook (FHWA-NHI-130078)
3. Bridge Inspector's Reference Manual (FHWA NHI 16-013)
4. Manual for Bridge Element Level Inspection (MBEI)
5. Specifications for the National Bridge Inventory (SNBI)

5.11.2 Equipment and Tools

Inspectors need the following equipment to inspect the wide variety of bridges encountered in Montana:

Inspection Equipment and Tools		
Steel-toe Boots	Toolbox	Digital Camera with Flash
Hard Hat	Tool Belt	Clipboard
Safety Vest	Geologist Hammer	Flashlight
Eye Protection	100' and 25' Tapes	D-Meter
Fall Protection Harness	6' Folding Rule	Calipers
Lanyard	Ladder	Temperature Gauge
Waders	Screwdriver	Depth Gauge
Sound Pole	Shovel	Increment Borers and Plugs
Plumb Bob	Pocket Knife	Binoculars
Lead Line	Wire Brushes	Industrial Crayons
Boat	Ice Pick	Inspection Tablet (optional)

5.12 Magnetic Particle Procedure Yoke Method

Magnetic Particle Testing (MT) is a nondestructive testing (NDT) method of revealing surface and slightly subsurface discontinuities in materials that can be magnetized. The testing method is based on the principal that magnetic flux in a magnetized object is locally distorted by the presence of a discontinuity. This distortion causes some of the magnetic field to exit and reenter the test object at the discontinuity. This phenomenon is called magnetic flux leakage. Flux leakage is capable of attracting finely divided particles of magnetic materials, which in turn form an outline, or indication of the discontinuity.

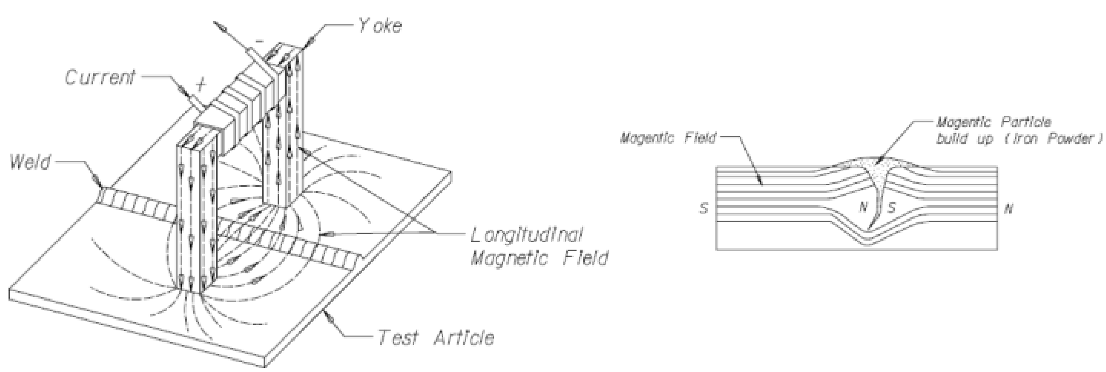


Figure 5.12-1 Magnetic Particle Testing of a Butt Weld

Montana Department of Transportation (MDT) personnel performing MT on state-owned structures or equipment will be qualified in accordance with this procedure prior to performing any inspections or interpretations of discontinuities.

5.12.1 Inspector Requirements

Inspectors will be required to complete a training course that will qualify them to inspect structures and assemblies by the Yoke method.

Inspectors will complete a method specific MT with a passing score of 80% weighted between a general, specific and hands-on practical test.

Level One (I)

Level I Inspector will complete eight (8) hours of classroom training and four (4) hours of hands-on equipment specific training. Twenty (20) hours of field training will be conducted with a current American Society of Nondestructive Testing (ASNT) Level II inspector.

MDT Level I individual will be qualified to properly perform specific calibrations, specific NDT, and specific evaluations for acceptance or rejection determinations according to written instructions. Level I inspectors may inspect materials, but only qualified Level II or III inspectors will be allowed to interpret results and record results.

Level Two (II)

Level II Inspector will complete four (4) hours of classroom training and four (4) hours of hands-on equipment specific training. Twenty (20) hours field training will be conducted with a current ASNT Level II inspector.

MDT Level II individual will be qualified to set up and calibrate equipment and to interpret and evaluate results with respect to applicable codes, standards and specifications. The NDT level II will be thoroughly familiar with the scope and limitations of the methods for which qualified and will exercise responsibility for on-the-job training and guidance of trainees and NDT level I personnel. The NDT level II will be able to organize and report the results of NDT tests.

Level Three (III)

Level III Inspector certification is administered by ASNT.

MDT Level III individual will be capable of developing, qualifying and approving procedures, establish and approving techniques, interpreting codes, standards, specifications and procedures; and designating the particular NDT methods, techniques and procedures to be used. The MDT Level III will be responsible for the NDT operations for which qualified and assigned and will be capable of interpreting and evaluating results in terms of existing codes, standards and specifications. The MDT Level III individual will have sufficient practical background in applicable materials, fabrication and product technology to establish techniques and to assist in establishing acceptance criteria when none are otherwise available. The MDT Level III will have general familiarity with other appropriate NDT Methods, as demonstrated by an ASNT Level III Basic examination or other means. The MDT Level III, in the methods in which certified, will be capable of training and examining MDT Level I and II personnel for certification in those methods.

5.12.2 Material Testing

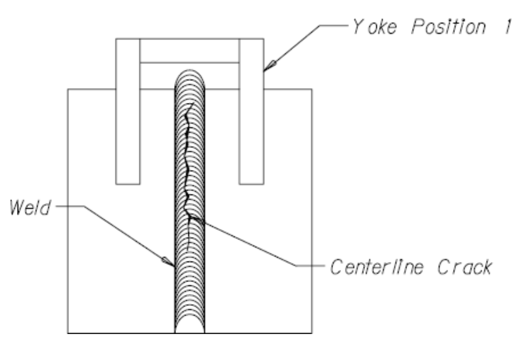
The test or (inspection) consists of six basic operations.

1. Calibration
2. Pre-cleaning
3. Establishing a suitable magnetic flux in the test object (Induced Field)
4. Apply magnetic particles
5. Examine the test object and interpret inspection results
6. Record and report the results.

Inspectors will be limited to the use of 110VAC portable test equipment and B300 AC Yoke. Equipment is to be calibrated using the ten (10) pound calibration block after eight (8) hours of continuous use or the beginning of each shift.

1. **Calibration**
   Yoke calibration will vary based on the yoke model and manufacturer. Follow manufacture-specific procedures for yoke calibration.
2. **Pre-cleaning**
   Remove all loose and flaking paint, rust, organics, water or anything that might interfere with the inspection process. Approved processes for removal are power wire brush, hand brushing or flapper disc sanding pad. MT inspection may be performed with a light covering of paint however; approved method would be to thoroughly clean the area as prescribed. Clean three (3) inches around the area to be inspected in all directions. Relevant indications that extend into the unclean area will be suitably cleaned. Care will be taken not to remove base material during cleaning.
3. **Inducing a Magnetizing Field**
   Magnetic Fields induced into the inspection area will be of the (Continuous Method) by energizing the Yoke and inspecting while AC current is on.
4. **Applying Magnetic Particles**
   Magnetic particles will be applied using the dusting bulbs or bottles. A light coating of particles applied will form flux lines and be attracted by defects in the inspection areas. Inspection will be conducted with the unaided eye. Lighting conditions may be enhanced with a flashlight or inductive light on the yoke.

5. **Examining the Test Object and Interpreting Results**

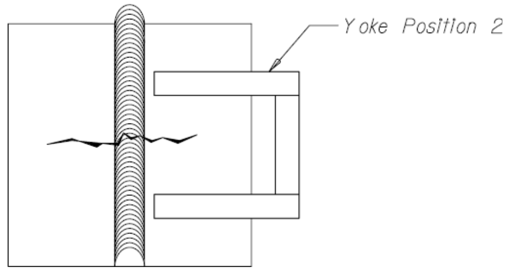


Note: Yoke legs are transverse of the area of interest.

Figure 5.12-2 Position 1 Cracks will appear perpendicular to the leg orientation.

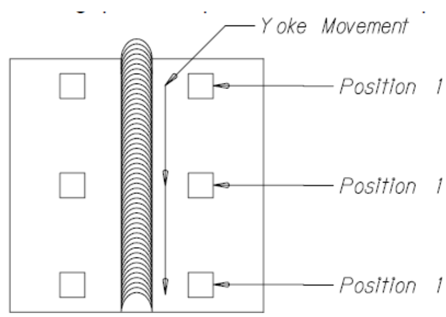
The yoke will be positioned such that suspected defect and the yoke legs are perpendicular to each other.

The yoke will be positioned such that the suspected defect and the yoke legs are perpendicular to each other. Rotate the yoke 90 degrees and inspect with the yoke in this position. This will reveal indications transverse of position 1.



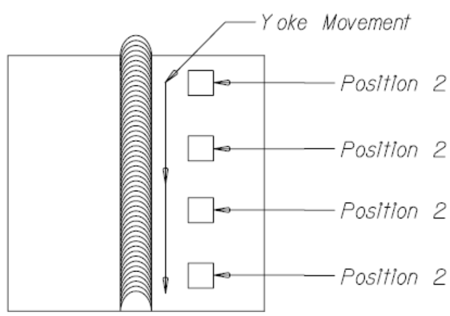
Note: Rotate yoke 90 degrees from position 1.

Figure 5.12-3 Yoke legs positioned parallel with the weld to produce crack indication.



Note: Maximum leg spacing 6 inches overlap. Spacing 5 inches overlap inspection 1 inch.

Figure 5.12-4 The yoke must be moved over the inspection area with an overlap of the legs by one (1) inch from Position 1.



Note: Maximum leg spacing 6 inches overlap. Spacing 5 inches overlap inspection 1 inch.

Figure 5.12-5 Rotate the yoke 90 degrees. Position 2 movement will overlap 1 inch.

6. Record and Report Indications

Relevant indications that are revealed and hold powder will be recorded on Magnetic Particle Inspection Report form. Drawings or photos to be attached on a separate page(s). Record length and orientation. Mark the indication on the inspection piece at the ends of the crack, do not mark over the defect (crack). Mark the length of the indication on the test piece.

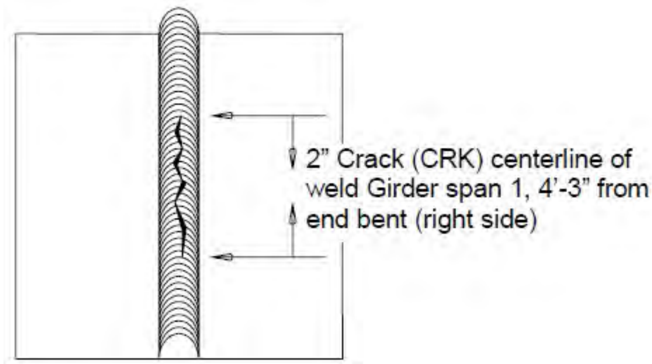


Figure 5.12-6 Typical Defect Marking

MONTANA DEPARTMENT OF TRANSPORTATION
BRIDGE BUREAU

MAGNETIC PARTICLE INSPECTION REPORT

Bridge Number:	Bridge Name:	
Bridge Location:		
Inspector:	ASNT Level:	Company:
Specification: In accordance with ANSI/AWSD1.5 -1996 Bridge Welding_Code [ ]		
Specification: In accordance with ANSI/AWSD1.5 -1996 Bridge Welding Code [ ]		

EQUIPMENT DATA					
Unit Mfg:	Model #	Serial #		Cal Date:	
Yoke:[ ]		Leg spacing: "			
METHOD					
Dry [ ]	Wet [ ]	AC [ ]	DC [ ]	Residual [ ]	Con t [ ]
PARTICLE					
Mfg:	Type:	Color:		Batch #	

Girder	Span	Pier	Indication #	Type	Left Side	Right Side	Accept	Reject

Additional space to orient the indications may be attached on a separate sheet

Comments:

We, the undersigned, certify that the statements in this record are correct and that the welds were prepared and tested in accordance with the requirements of:

ANSI/AASHTO/AWS			
Inspector/	Signature	Level	Date:
Review/	Signature	Level	Date:

Chapter 5 Appendix

Appendix 5A
Glossary

Axial Force	A force whose line of action is directed through the centroid of a member's cross-section.
Beam	A structural member subjected to transverse loading. Beam is a general term used to describe such members as girders, stringers, and floor beams.
Bearing	A structural member used to support a beam at its end or at some intermediate point.
Cantilever	A beam supported at one end only, or that portion of a beam which projects beyond a point of support.
Centroidal Axis	The axis of a structural member which passes through its cross-sectional center of gravity.
Compression	The stress resulting from a member or portion of a member being squeezed or shortened
Continuous Beam	A beam supported at intermediate points along its length. It must have at least one support between its end supports.
Contraflexure	See "inflection point."
Counter	Diagonal member of a truss panel, which is opposed, by a member in the same panel running in a perpendicular direction. Both members are very slender and, therefore, will accept only a very small compressive load. The counters work in tandem. As a live load crosses the bridge, only that member which carries the shear in that panel as a tension load will function.
Couple	Two forces heading in exactly the opposite direction and spread some distance apart. When acting on a body, a couple will cause it to rotate.
Dead Load	A fixed position gravity load. The permanent load on a structural member. The weight of the structure and any permanent attachments are dead loads.
Equilibrium	The state in which the resultant of all forces acting on a body is zero. For a body to remain at rest, this condition must be satisfied. If a body is in equilibrium, any isolated part of the body must also be in equilibrium.
Floor Beam	A transverse beam connecting main longitudinal components, usually trusses or large girders. A floor beam is used to support smaller longitudinal components (stringers), in effect creating a series of "mini-spans" within the main span.
Free Body Diagram	A sketch of an isolated body and all the external forces acting on it.

Inflection Point	The point in a continuous beam at which the moment due to dead loads is equal to zero. At these locations, the movement of live loads may cause the total stresses to fluctuate between tension and compression.
Line of Action	A line through which a force is directed.
Live Load	Loads acting when a structure is in service, but varying in magnitude and location over time. The main live load is truck traffic, but live load also includes all vehicular traffic as well as lateral loads like wind, ice flows, earthquake, etc.
Moment	The moment about a specific point within a body is the algebraic sum of all individual moments about that point. Each moment is equal to some force acting on the body multiplied by its moment arm to the point.
Moment Arm	The distance perpendicular from the line of action of a force to the point about which the moment is being taken.
Neutral Axis	Locations in the cross section of a member where bending stresses are zero. Usually, it coincides with the centroidal axis.
Principal Stress	The stress applied normal (perpendicular) to the cross section of a member. It refers to the axial stress in a truss member and the tension and compression stresses in bending.
Propagate	Term used to describe the continuation of the ends of a crack. This can only occur when the faces of the crack are being pulled apart by a tensile force.
Simple Beam	A beam supported only at its ends. Bearing is all that is provided by the supports. The ends of the beam are free to rotate.
Stress	The load intensity a material experiences when subjected to a force. It is the load per unit area.
Stress Cycle	The range of stress from a minimum to a maximum that a member experiences during one application of a live load.
Stress Concentration	An increase in stress caused by an irregularity in geometry. There is usually a localized variation in the overall stress in the immediate vicinity of the irregularity. The peak stress at these locations may be several times larger than the stress level in the bulk of the member.
Tension	The stress resulting from a member or a portion of a member being pulled or stretched.
Yield Point	The level of stress at which a material (steel) will begin to deform plastically. Before it reaches

	this level, the steel will behave elastically, meaning it will sustain a load and bounce back. After surpassing this level, any deformation will be permanent.

Chapter 6 – Conditions and Appraisals

6.1 Specifications for the National Bridge Inventory (SNBI) Inspection

SNBI requirements include specific SNBI items related to a bridge that record a variety of design, appraisal, inventory, and condition data associated with each bridge.

Refer to the SNBI with MDT commentary for full descriptions of each item. See Appendix 4E for a list of SNBI elements that are the responsibility of the inspector.

6.1.1 SNBI Condition Items

Inspectors must follow FHWA's *Specifications of National Bridge Inventory* with MDT Commentary for the SNBI items. Some additional guidance is listed in this section.

Component condition ratings must consider the type, extent, and severity of the defects: the extent to which they exist throughout the item being evaluated, and the degree to which the defects affect strength and/or performance of the bridge or component. In other words, in most cases, inventoried element defects and their corresponding ratings and notes will directly correlate to the SNBI rating.

6.1.2 Extent of Defect Severity

The most severe defect encountered during an inspection will provide a range for the inspector to narrow down a component condition rating. For example, if the most severe defect found during an inspection was a moderate defect, the range for acceptable SNBI ratings is 4 to 6.

To narrow down component condition ratings to a single value the State has defined the following terms which describe the extent of defect severity.

Use for Extent of Defect Severity for Deck Components or Single Elements

Table 6.1-1 SNBI B.C.01-04 Rating Guideline

Isolated	Less than 15% of parent element quantity.
Some	15% to 50% of parent element quantity.
Widespread	Greater than 50% of parent element quantity.

For Superstructure or Substructure Components Comprised of Two or More Elements

When more than 50% of the combined elements of a component are found to have a widespread defect of a certain severity, then the component will be considered to have widespread defects of that severity.

6.1.3 Examples Determining Condition Ratings

6.1.3.1 Example 1

A bridge substructure consists of two elements, RC abutments and RC pier walls. The RC abutments were found to have widespread minor defects. The RC pier walls were found to have no defects.

The worst component defect is a minor defect. Since 1 of the 2 (50%) elements are considered to have widespread minor defects, the extent of minor defects is not considered widespread. The component condition rating is best characterized as having some minor defects, SNBI=7.

6.1.3.2 Example 2

A bridge substructure consists of three elements, RC abutments, RC Caps, and RC Columns. The RC abutments are found to have widespread minor defects and isolated moderate defects. The RC caps have some minor defects and some moderate defects. The RC Columns have widespread moderate defects.

The worst component defect is a moderate defect. Since 1 of the 3 (33%) elements are considered to have widespread moderate defects, the extent of moderate defects is not considered widespread. The component condition rating is best characterized as having isolated or some moderate defects, SNBI=5 or 6.

6.1.3.3 Example 3

A bridge superstructure consists of four elements, steel truss, steel gusset plates, steel stringers, and steel floorbeams. The steel truss was found to have isolated minor defects and widespread moderate defects. The steel gusset plates were found to have some minor defects and widespread moderate defects. The steel stringers were found to have widespread minor defects and isolated moderate defects. The steel floorbeams have widespread moderate defects.

The worst component defect is a moderate defect. Since 3 of the 4 (75%) elements have widespread moderate defects, the component is considered to have widespread moderate defects. The component condition rating is best characterized as having widespread moderate defects, SNBI=4.

6.1.4 Component Condition Notes

When one of the component conditions listed below is rated 6 or less, an associated component condition note is required.

B.C.01 Deck Condition Rating
B.C.02 Superstructure Condition Rating
B.C.03 Substructure Condition Rating
B.C.04 Culvert Condition Rating
B.C.09 Channel Condition Rating
B.C.10 Channel Protection Condition Rating
B.C.11 Scour Condition Rating
B.C.14 NSTM Inspection Condition
B.C.15 Underwater Inspection Condition

6.1.5 Members Supporting Bridge Including Temporary Members

Temporary or permanent supporting members in place to keep the bridge open pending the completion of active or imminent repair, or replacement projects shall be evaluated as part of the component condition ratings. These supporting members include shoring, supports, repairs, or supplemental members.

All supporting members will be documented in the routine bridge inspection report. Inventory each supporting member under the best-fit element, based on its function and material, using the elements defined in the MBEI or Chapter 8 of this manual.

Inspectors must describe all support conditions. Consider the condition of temporary members when evaluating portions of bridge components supported or strengthened by temporary members. For more information on temporary members see Section 7.1 of the SNBI with MDT Commentary.

6.1.6 Repaired or Rehabilitated Components

Repairs or rehabilitation may increase the SNBI condition ratings; however, do not rate repaired components higher than 7.

Do not increase the condition rating for repairs that are intended to be temporary in nature, such as bituminous patches in concrete decks, or for repairs that do not fix the defect, but only arrest or slow down deterioration, such as painting.

Rate components that are completely replaced, such as a new deck at an 8 or 9, based on the observed conditions, as necessary.

6.2 Element Level Inspection

There are over 100 different standard NBE and BME elements, along with the 30+/- ADE elements grouped into a logical numbering sequence:

1-99	Deck Elements
100-199	Superstructure Elements
200-299	Substructure and Culvert Elements
300-599	Miscellaneous Elements
800-999	Agency Defined Elements

Up to 40 elements may be used on a large or complex structure inspection, however most typical bridges will consist of 4 to 12 elements.

Add all appropriate elements to a bridge during the initial inspection to appropriately describe and track conditions of all portions of the structure. Subsequent inspections in BrM will carry forward these elements in future inspections. During each inspection, verify that the elements describing the structure are correct and complete. Add or remove elements and adjust quantities as needed. Add a general note to the report to explain any additions or deletions of elements.

6.2.1 Defects and Condition State Rating

There are many possible defects for bridge elements. These defects include material defects such as corrosion in steel, spalling in concrete, decay in timber, as well as other, non-material defects such as settlement or distortion in culverts.

Each individual element (NBE, MBE and ADE) has a specific list of possible defects and associated defect codes. When a defect is noted along an element, the code for the proper defect is selected (i.e., code 1080 for spalling), and the total quantity of the defect is entered. The total quantity of the defect is then placed in the appropriate Condition State (CS2, CS3, or CS4) or split between the 3 condition states, but must add up to the total quantity of the defect entered. Generally, the quantity of a defect is zero in CS1 and defects are not added when quantity would be 100% CS1.

All defects should be recorded regardless of whether they overlap with other defects. The total of condition states 2 to 4 for any given defect should not exceed 100% of the total quantity of said defect. The defect condition state quantities are then “rolled up” to the parent element, taking into account defects that overlap in a specific condition state.

Once all defect quantities are rolled up to the parent element, the total of the condition states (CS1 – CS4) of the parent element must total 100% of the total quantity of the parent element.

The default coding method is unit specified in the MBEI or Chapter 8. When rounding quantities for either the parent element or a defect, quantities should be rounded to the nearest whole unit. No decimal units should be recorded. The quantity unit must stay as a whole number.

6.2.2 Element and Defect Comments

Comments summarizing the conditions of the entire element are required for each element.

Comments are also required for each defect. Defect comments specifically describe the condition for each condition state. These comments should contain the following:

- quantity of the defect in each condition state
- location of the defect
- a descriptive comment of the condition

Comments for each element and defects do not need to be original for each inspection event, but the full description must be entered (or repeated from a previous inspection) and include additional comments for any condition changes. Do not enter “previous comments apply” or anything similar that only references past comments. Past comments are not visible in the inspection reports, and we do not intend to make anyone open multiple inspection reports to find applicable comments.

6.2.3 Environment

To model the deterioration of elements, knowing the environment of each element is necessary. Elements exposed to different environmental factors and service environments deteriorate differently. These factors may include:

- Operational activities from traffic volumes and truck movements,
- Exposure to water, road salt and other corrosive materials,
- Condition of protective and waterproofing systems, or
- Temperature extremes and differentials, either from nature or human activity

In Montana, different bridges have a variety of environmental exposures due to geographic location, topography, humidity, varying temperature extremes, length of freeze-thaw season, varying levels of chloride or salt use, as well as varying truck and general traffic volumes. Environmental factors in BrM are determined and coded by the Bridge Management Section.

6.3 Element Descriptions and Identification

This section generically covers the main structural elements used in element inspection and coding. This is not all-inclusive but gives general guidance on how a structure is to be coded. Unless otherwise noted, these descriptions are for all material types.

6.3.1 Deck/Slab Elements

Deck

The deck is the part of the bridge that directly carries the traffic loads. It transfers the vehicle wheel loads to the superstructure.

Slab

A slab is a deck that also acts as a superstructure. Girders and other similar superstructure elements are not used when a slab is present. A slab transfers the vehicle load directly to the substructure.

Top Flange

The top flange is the portion of a tee-beam or box beam type structure that carries the traffic loads. This is defined as the part of the beam from the web fillet up to the riding surface and is shaded gray in Figure 6.3-1.

Deck Concrete Protective Coating

Deck concrete protective coating can only be coded based on visual inspection. *The protective coating includes thin material coatings such as high molecular weight methacrylate, epoxy overlays, polymer overlays, or similar. It does not include asphalt overlays or cementitious overlays.*

If the concrete protective coating can be seen on the entire surface of the deck, code the coating as Condition State 1. If the coating is missing only on the deck surface in the wheel paths or in other limited random areas but is covering the remaining bridge deck surface or visible in the cracks, code the coating in Condition State 2. If the coating is only visible along the shoulders or deck edges, code the coating in Condition State 3. If the coating is not visible or only visible along the narrow untraveled edge of the deck, code the coating in Condition State 4.

The quantity for protective coatings is measured in units of square feet (sq.ft).

6.3.2 Superstructure Elements

Girder/Stringer

Girders are longitudinal members that are primary load carrying members of a superstructure. They span from substructure unit to substructure unit. In the past, girders and stringers have been incorrectly used interchangeably for beams on short span bridges. Stringers are distinctly different than girders and are defined on the following page.

For box girder and tee-beam bridges, two elements are required to be coded. Code the riding surface as a Top Flange (shaded section of Figure 6.3-1). Code the web and bottom flange below the top flange/web fillet, as a girder (the unshaded area of the girders in Figure 6.3-1).

When inventorying quantities for Timber Girder Elements (111) or Timber Stringer Elements (117), count the quantity of each girder or stringer as the span length (center of pile cap to center of pile cap). This helps inspectors avoid rating the condition of overhangs, especially where timber girders have large overhangs into the next span.

All other girder types are inventoried as the full length of each girder.

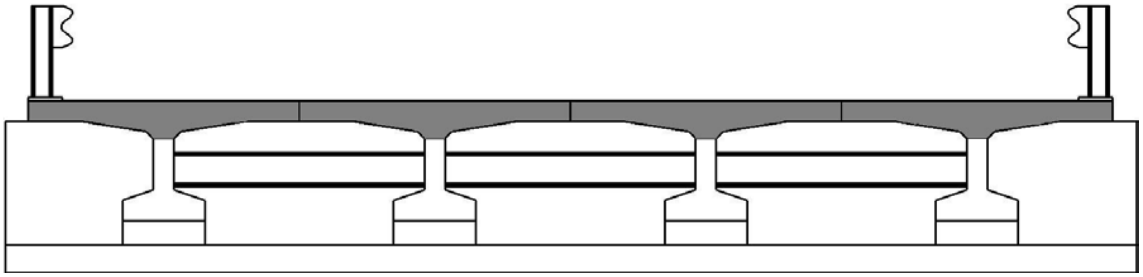


Figure 6.3-1 Typical Bulb-Tee Girders.

Truss

A truss is a longitudinal main load carrying member that is made up of a top chord, bottom chord, verticals, and diagonals, which form triangles when connected. All members that make up the main truss sections carry only axial forces (any moment or shear loads in truss members are negligible and limited to self-weight). All trusses will have a floor system that typically consists of stringers, floorbeams, and a deck that carries and transfers the traffic loads into the truss at nodal points. There are many types and designs of trusses, including, but not limited to through trusses, partial-through trusses, pony trusses, and deck trusses.

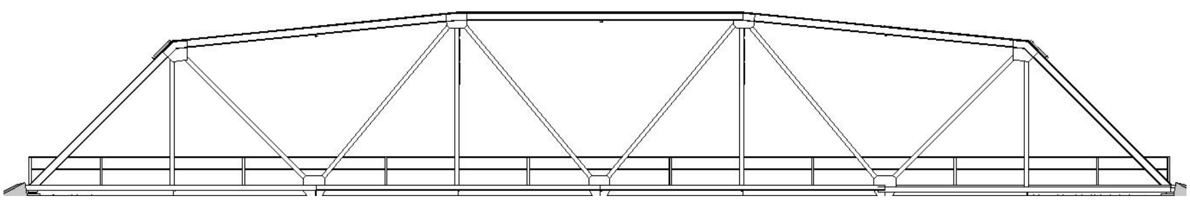


Figure 6.3-2 Typical Truss.

Arch

An arch is a longitudinal main load carrying member that is shaped like an arc and is always in compression.

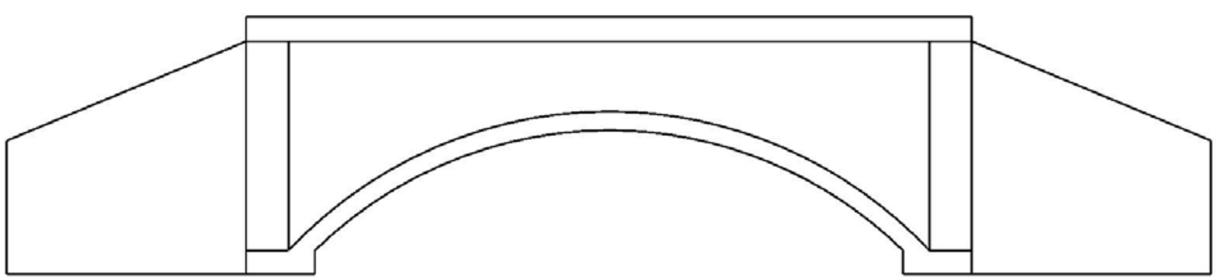


Figure 6.3-3 Typical Simple Arch.

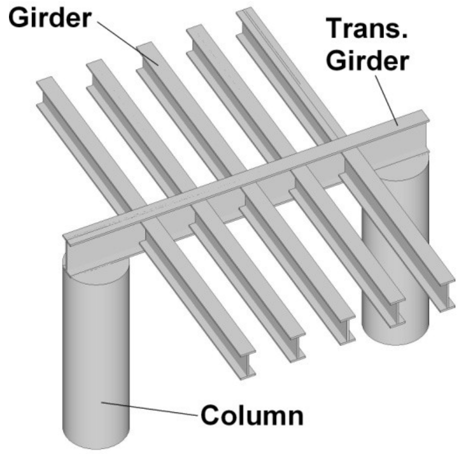


Figure 6.3-4 Typical Transverse Girder.

Stringer

A stringer is a longitudinal beam element that transfers loads from the deck to floorbeams and abutments.

Floorbeam

A floorbeam is a transverse element that transfers loads from the deck and/or stringers to the main longitudinal superstructure members (girders, truss, or arch).

Transverse Girder

A transverse girder is a steel element that carries the load from the deck or girders directly to the substructure through the bearings. See Figure 6.3-4 and Figure 6.3-5 for a drawing of a typical transverse girder.

Transverse girders are used at overpasses where a long transverse span length is needed, and clearance requirements will not allow the use of a typical bent cap supporting the longitudinal beams from underneath. When transverse girders consist of two separate beams or sections, it gives some measure of redundancy. However, should one section fail, the other cannot be expected to carry both spans. Therefore, whether a single member or double member is used, the transverse girder is a Nonredundant Steel Tension Member.

To distinguish between a transverse girder and a steel cap, look at how loads are transferred from the superstructure to the substructure. A transverse girder transfers forces to the substructure through the bearings and is part of the superstructure. Caps do not have bearings under them and are considered substructure members.

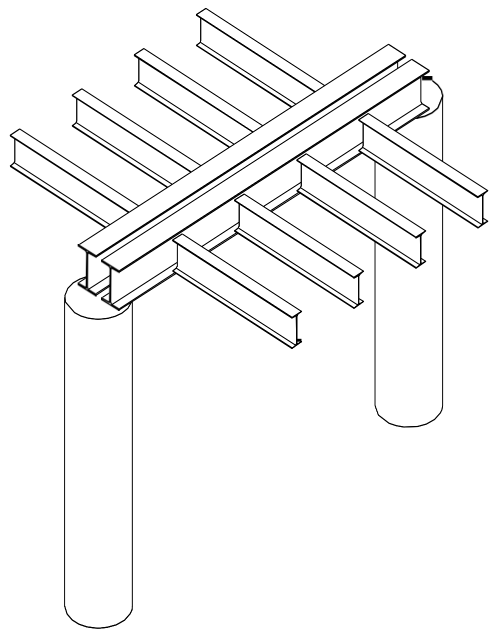


Figure 6.3-5 Transverse Girder.

Transverse girders are simply supported Nonredundant Steel Tension Members. During inspections, place close attention to the following locations:

- The bottom half (tension section) of the entire length of the member(s).
- The bolted or riveted connection plates between the longitudinal girders and the transverse girder.
- The pins and nuts in pinned connection assemblies (although a pinned connection will eliminate the prying action concerns).

The ends of welded cover plates, if present.

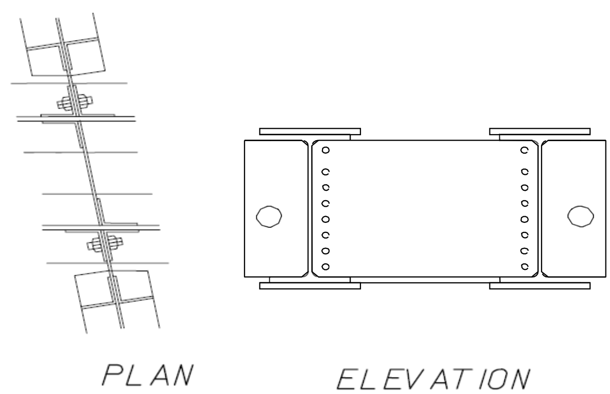


Figure 6.3-6. Pinned Beam Connection Detail.

6.3.3 Substructure Elements

Column

A column is an element that transfers loads from a pier cap or superstructure bearing to a footing or pile cap. Columns differ from piles, in that columns do not transfer load to the soil.

Concrete Pier Wall

A concrete pier wall is a wall that transfers loads either directly from the superstructure or from the pier cap to the pile cap, footing, or piles. Web walls are not pier walls, and should not be coded as pier walls, since they are typically not designed to transfer gravity loads.

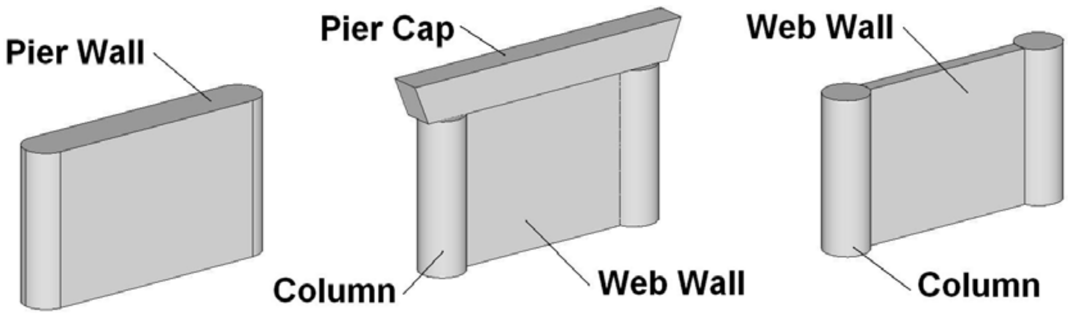


Figure 6.3-7 Typical Concrete Pier with Walls.

Timber Pier Wall

A timber pier wall typically consists of a standard timber bent (piles or columns) that has a continuous covering of transverse boards attached to the piles. These boards are usually adjacent to each other vertically, preventing direct visual inspection of the piles where they are covered. Pier walls may either be full height of a bent, extending the bottom of the cap to the ground or water level (or below), or they may only be partial height, allowing some visual inspection of the piles. Other types of timber pier walls consist of timber cribbing filled with gravel or rocks. These may or may not have an angled nose upstream to help divert water around the pier wall.

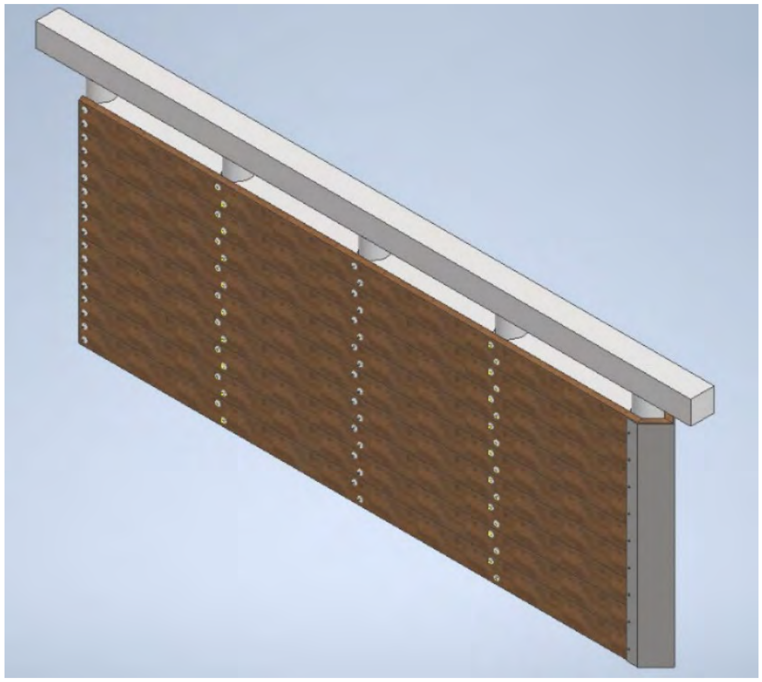


Figure 6.3-8 Typical Timber Pier Wall.

Figure 6.3-9 Timber Cribbing Pier Wall.

Pier Cap

A pier cap is an element that transfers loads from the girder or girder bearings to the columns, pier wall, or piles. Bump outs on top of pier walls are not considered pier caps.

Concrete Pile Cap

A concrete pile cap is an element that transfers the loads from the pier wall or columns to the embedded piles that do not extend up to the underside of the superstructure. See Figure 6.3-10.

Bearings

Bearings are added as Elements (or included in the quantity of bearings) only if one or more anchor bolts are visible on each individual bearing. If a bearing is only partially exposed and no anchor bolt is visible, do not add a bearing element or count the individual bearing in the bearing quantity. If comments are necessary for partially visible bearings, place the comments under the substructure element.

Bearings protective coating should be coded as a percentage of the total quantity rounded to the nearest square foot using only the Effectiveness defect. The protective coating quantity for each individual bearing should always be 1 square foot.

Footing

A footing is an element that transfers the loads from the pier wall or columns directly to the ground. Typically constructed of concrete, although timber sills may be present on small structures that would be considered a footing.

Pile Caps and Footings

Exposed footings and pile caps may be present with abutment or pier wall elements. Add this element when the footing or pile cap is a deliberate, formed component of the substructure wall. Do not add this element due to unintended formwork errors, failures, or substructure reconstructions that result in varying wall widths or false footings.

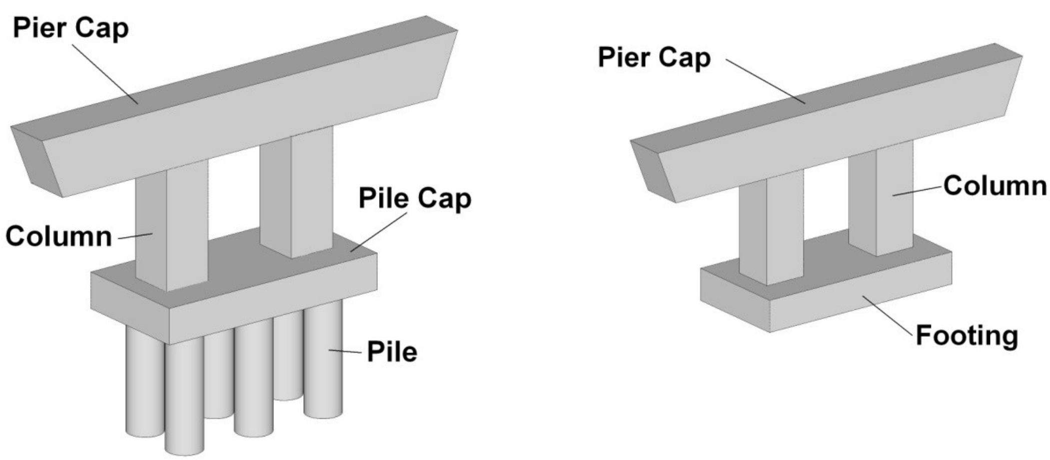


Figure 6.3-10 Typical Concrete Pier with Columns

Piles

Piles are elements that transfer load from a pile cap, pier cap, or other substructure elements to the ground. They are mechanically driven into the ground, as opposed to columns, which are not driven. Note that portions of piles above the ground and water surface are referred to as pile extensions and are coded as Piles.

Pile Cap *(any material)*

A pile cap is a separate element that transfers loads directly from girders or bearings into piles or columns that extend up to the underside of the superstructure. See Figure 6.3-11.

Abutment

An abutment is the superstructure support element at the beginning and ending of the structure that transfers loads from the superstructure to the ground. Use the following guidance to determine the portion of each abutment to be included in the Abutment Element:

- For abutments with piles/columns, cap and backwall:
    - Concrete abutments include the backwalls and integral wingwalls. Non-integral wingwalls are not included.
    - On concrete abutments with a load bearing backwall, the abutment element is the full length of the abutments. This length only includes wingwalls if they are integral to the backwall (no joint between backwall and wingwalls).
    - Timber and steel abutments include the backwall and piles. The wingwalls and wingwall piles are only included when the wingwalls are integral (the backwall and wingwalls are all one piece with no joint between them).
    - The caps and pile/column elements are coded separately for timber and steel abutments. They are only coded separately for concrete abutments when they meet the following criteria:
        - Cap – when the abutment has a cap supporting the girders that is wider than the abutment wall).
        - Columns – when the columns are the main load bearing portion of the abutment instead of the abutment wall. If both the columns AND the abutment wall carry load, include the columns in the abutment and do not code them separately.
        - Piles – always when visible for inspection.
- Integral wingwalls (where material exists continually with no gaps or joints between abutment stem and wingwalls or straight timber plank backwalls that extend beyond the shadow of the superstructure) are included in the abutment quantity and rated under the abutment element.
    - Non-integral wingwalls are not rated under the abutment elements (e.g., where a joint exists between the abutment stem and wingwalls or turn-back timber wingwalls). These should be coded under ADE element 916 Non-Integral Wingwalls.

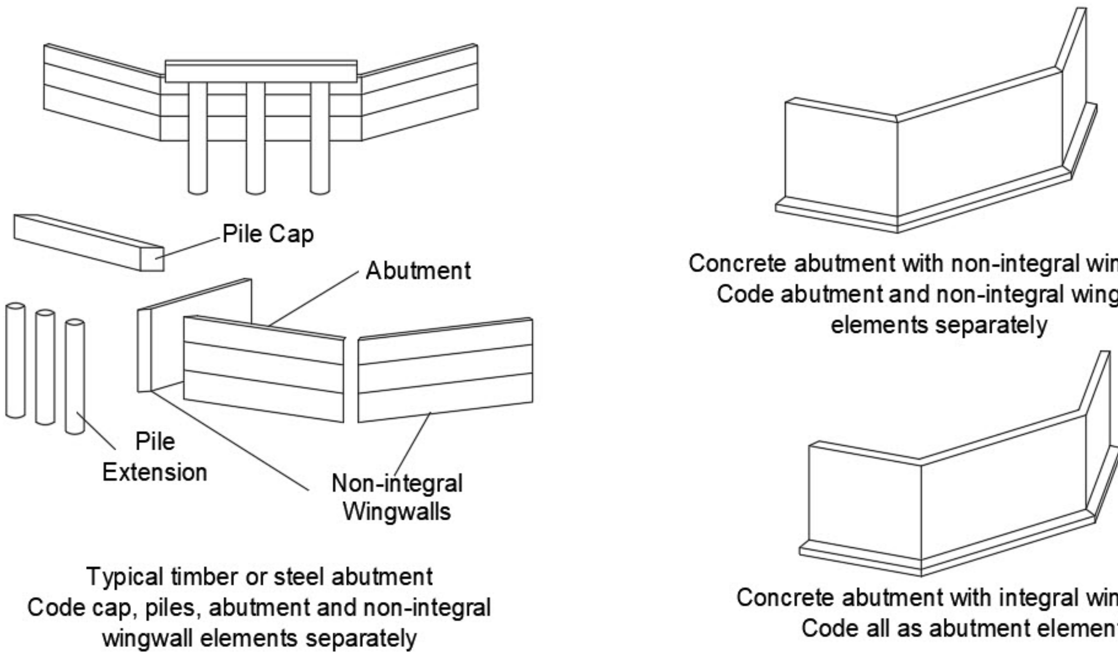


Figure 6.3-11 Typical Abutments

Column Tower (Trestle)

A column tower or trestle is a built up or framed tower support. The term for a steel version is a tower, and the timber version is a trestle.

Submerged Pile

A submerged pile is the section of the pile that is below the water line on bridges that receive an underwater diving inspection. This element is not used for probe and wade inspections.

Submerged Column

A submerged column is the section of the column that is below the water line on bridges that receive an underwater diving inspection. This element is not used for probe and wade inspections.

Submerged Pier Wall

A submerged pier wall is that portion of the pier wall that is below the water line on bridges that receive an underwater diving inspection. This element is not used for probe and wade inspections.

Submerged Footing/Pile Cap

This element is for footings and pile caps that are underwater and are exposed by design or by scour of the soil around them on bridges that receive an underwater diving inspection. This element is not used for probe and wade inspections.

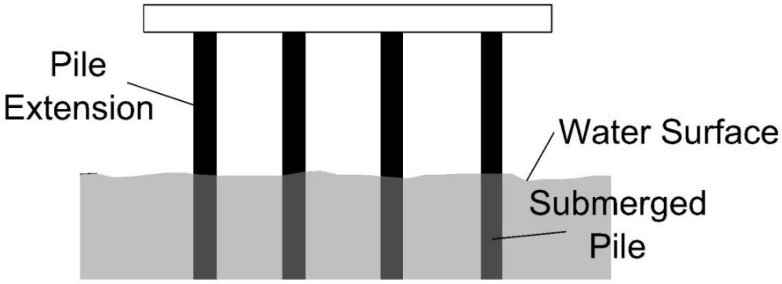


Figure 6.3-12 Submerged Piles

6.3.4 Table of Elements

This section lists all bridge elements including National Bridge Elements (NBE), Bridge Management Elements (BME) and Agency Defined Elements as well as a matrix for element defects. Underlined elements are the Agency Defined Elements unique to MDT. See Chapter 8 for detailed information on ADEs.

Deck Elements: Material	Units	Element Number (Deck)	Element Number (Slab)	Element Number (Top Flange)
Reinforced Concrete	sq ft	12	38	16
Prestressed Concrete	sq ft	13	39	15
Steel - Open Grid	sq ft	28		
Steel - Concrete Filled Grid	sq ft	29		
Steel - Corrugated/Orthotropic/Etc.	sq ft	30		
Timber	sq ft	31	54	
Other	sq ft	60	65	

Superstructure Elements	Units	Steel	Prestressed Concrete	Reinforced Concrete	Timber	Masonry	Other
Open Girder/Beam	ft	107	109	110	111		112
Closed Web/Box Girder	ft	102	104	105			106
Stringer	ft	113	115	116	117		118
Truss	ft	120			135		136
Arch	ft	141	143	144	146	145	142
Floor Beam	ft	152	154	155	156		157
Transverse Girder	ft	810	811				812
Railroad Car	ft	815					
Cable – Primary	ft	147					
Cable – Secondary	each	148					149
Pin, Pin and Hanger Assembly, or Both	each	161					
Gusset Plate	each	162					
Primary Cable Saddles	each	164					

Superstructure Elements	Units	Steel	Prestressed Concrete	Reinforced Concrete	Timber	Masonry	Other
Cable Anchorage Socket or Assembly	each	165					
Truss Vertical Cross-Frame	ft	820					
Curved Girder Diaphragm	ft	821					

Substructure Elements	Units	Steel	Prestressed Concrete	Reinforced Concrete	Timber	Masonry	Other
Column	each	202	204	205	206		203
Column Tower (Trestle)	ft	207		237	208	238	
Pier Wall	ft			210	212	213	211
Abutment	ft	219		215	216	217	218
Pile	each	225	226	227	228		229
Pier Cap	ft	231	233	234	235		236
Pile Cap/Footing	ft			220	855		
Non-Integral Wingwall	ft						916
GRS-IBS Retaining Wall	ft						910
Anchorage Chamber Walls	ft	222		221		223	
Reinforced Concrete Anchorage Block	each			224			
Submerged Column	each	860	861	862	863		864
Submerged Pier Wall	ft			870	871	872	873
Submerged Pile	each	880	881	882	883		884
Submerged Pile Cap/Footing	ft			890	891		
Non-Structural Retaining Wall	ft	911		912	913	914	915

Other Elements	Units	Element Number
Joints		
Strip Seal Expansion	ft	300
Pourable Joint Seal	ft	301
Poured In Place Plug Joint System	ft	301A
Compression Joint Seal	ft	302
Bonded Preformed Joint Seal	ft	302A
Bonded Foam Joint Seal	ft	302B
Assembly Joint with Seal	ft	303
Segmental Joint System	ft	303A
Modular Joint Assembly	ft	303B
Open Expansion Joint	ft	304
Assembly Joint without Seal	ft	305
Sliding Plate Joint Assembly	ft	305A
Finger (Tooth) Joint Assembly	ft	305B
Other Joint	ft	306
Approach Slabs		
Prestressed Concrete Approach Slab	sq ft	320
Reinforced Concrete Approach Slab	sq ft	321
Bridge Railings		
Steel Bridge Railing	ft	330
Reinforced Concrete Bridge Railing	ft	331
Timber Bridge Railing	ft	332
Other Bridge Railing	ft	333
Masonry Bridge Railing	ft	334
Protective System		
Wearing Surfaces	sq ft	510
Steel Protective Coating	sq ft	515
Cable Protective System	ft	518
Corrosion Resistant Reinf. System - Metallic	sq ft	990
Corrosion Resistant Reinf. System – Non-Mettalic	sq ft	991
Concrete Reinforcing Steel Protective Systems	sq ft	520
Concrete Protective Coatings	sq ft	521
Bearings		
Elastomeric	each	310
Movable (roller, sliding, etc.)	each	311
Enclosed/Concealed	each	312
Fixed	each	313
Pot	each	314
Disk	each	315
Other	each	316
Miscellaneous Elements		
Vibration Dampers	each	308
Deck Drainage	each	340
Substructure Impact Protection	each	350
Steel Primary Cable Bands/Splay Castings	each	360
Post-Tensioning Anchor	each	370

Other Elements	Units	Element Number
Miscellaneous Elements		
Transverse Post Tensioning Anchor	each	825
Scour	each	900
Scour Countermeasures	each	901

Off-Bridge Elements	Units	Steel	P/S Concrete	Reinf. Concrete	Timber	Masonry	Other
Approach Guardrail	ft	950		951	952		953
Approach Guardrail Ends	ft	960					
Approach Roadway	each						965
Erosion	each						970
Loss of Roadway Fill	each						971

See AASHTO's *Manual for Bridge Element Inspection* for more information on condition states and element defects for all elements that are not Agency Defined. See Chapter 8 of this manual for additional information on Agency Defined elements and their defects.

6.3.5 Off-Bridge Elements

Element 950 - Approach Guardrail includes both the rail transitions and approach rail sections. This Element 950 will not exist if:

1. An Approach Guardrail End Treatment exists (See Element 960 description below).

AND

2. There is less than 50 ft of End Treatment and rail.

AND

3. The end treatment and rail meet current standards.

Element 950 will exist if the following conditions are met and will include:

1. Any rail that is greater than the 50 feet that is included in Element 960

OR

2. If Element 960 does not meet current standards, use field judgment to determine the quantity included in Element 950 (See Element 960 description below)

Element 950 is quantified by linear feet. No Protective coating is added for this element. Round condition state quantities to the nearest foot.

Element 960 - Approach Guardrail Ends, when installed to meet current standards, includes 50 feet of rail with an end treatment, or an impact attenuator, at each bridge corner for bridges carrying two-way traffic or on both corners facing oncoming traffic on bridges carrying one-way traffic. Element 960 is not determined based on the crash testing of the End Treatment but is determined by the presence of some form of End Treatment. If the End Treatment is less than 50 feet, use your judgment in the field to determine how much rail to include in Element 950 and add a comment. Element 960 can exist with no Element 950 present (the End can be mounted directly to the Bridge Rail). Element 960 is quantified by each. No Protective coating is added for this element. Round condition state quantities to the nearest full unit.

6.4 Guidance on Element Condition Assessment of Bridges with Typical Repairs

6.4.1 Timber Widening

Many State-Owned timber bridges have been widened beyond their original construction width. As part of the widening, a common detail involved placing a new girder directly adjacent to the original exterior girder. Girders that are next to each other as part of a widening are not true sister girders since they support the widened portion of the timber deck. Always include these girders in element 111 (Timber Girder) and have standard girder numbering nomenclature in Section 6.4.5. In addition to new girders, a new deck was typically added adjacent to the original deck rather than rebuilding the entire bridge deck. In many cases, this widened portion is a plank deck, not a nail-laminated deck like most of our bridge decks are. It is important to note this difference in timber bridge measurement forms.

6.4.1.1 Sister Girders on Timber Bridges

In past guidance, original timber girders with helper girders, a.k.a. “sister” girders, have not been included in element 111 (Timber Girder) quantity. However, many of the girders that were repaired in past years with a helper girder still have capacity to carry load. Include these original girders in the element 111 quantity when it can be determined that they still have capacity to carry loads. Follow this guidance and flow chart to determine whether to include the original timber girder in element 111 (Timber Girder) quantity and the numbering nomenclature of all girders.

6.4.2 Sister Girders with Properly Documented Installations

To address deficiencies in live load, steel sister girders have been recently (generally 2021 and later) installed by MDT Maintenance. These installations have been documented in the BrM repairs tab and include a completed post-rehab inspection and an updated load rating. The post-rehab inspection will likely have a comment about the timber girder quantity in the inspection comments. If the comment in the post rehab inspection indicates that the original timber girder was determined to have the ability to carry load during the post-rehab inspection, include it in the Element 111 quantity. If it is not apparent in the comments of the post-rehab inspection whether the original girder was determined to have the ability to carry load or if there is additional deterioration that is discovered during an inspection on the original timber girder, use inspection experience and best judgment to determine if the girder can carry load. Adjust the element 111 quantity as necessary after determining if the girder can carry loads and whether it is currently included in the quantity.

6.4.3 Sister Girders with No Documented Installations

Evaluate any original timber girders that have a sister girder with no properly documented repair in BrM. Evaluate the girders on an individual basis for their ability to carry load.

If the original girder is broken, cracked, or deteriorated to the point that it no longer has any capacity to carry load, do not include the girder in the element quantity. This determination should be based on MDT timber inspection guidance, inspection experience, and an inspector’s best judgment. Although girders that are determined to have no capacity are not to be included in the timber girder element quantity, they should still have their defects noted in the inspection (see below for more details).

If there are defects that will affect the shear or moment capacity, but the girder still has capacity to carry some load, include the original girder in the element quantity. Document the deteriorated girder that is suspected to have some capacity with adequate photos, comments, and descriptions. This will allow the Load Rating Engineer to use the MDT Interim Guidance memo Load Rating of Timber Bridges and engineering judgment to determine the appropriate allowable capacity to assign to the girder.

Example Comment:

> *Span X Original Girder X has a sister girder on the (Right/Left) due to a (Describe defect) in the original timber girder. This girder has not been included in the element quantity due to the defect and is not included in the defect quantity.*

6.4.4 Sister Girder Naming Convention

Original girders with sister girders have a different naming convention than what was used prior to 2021. Use the following naming convention to number bridge girders with sister girders:

- The original girder number should always remain the same.
- The sister girder will have a name corresponding to the original girder number and what side (right or left) the sister girder is on.

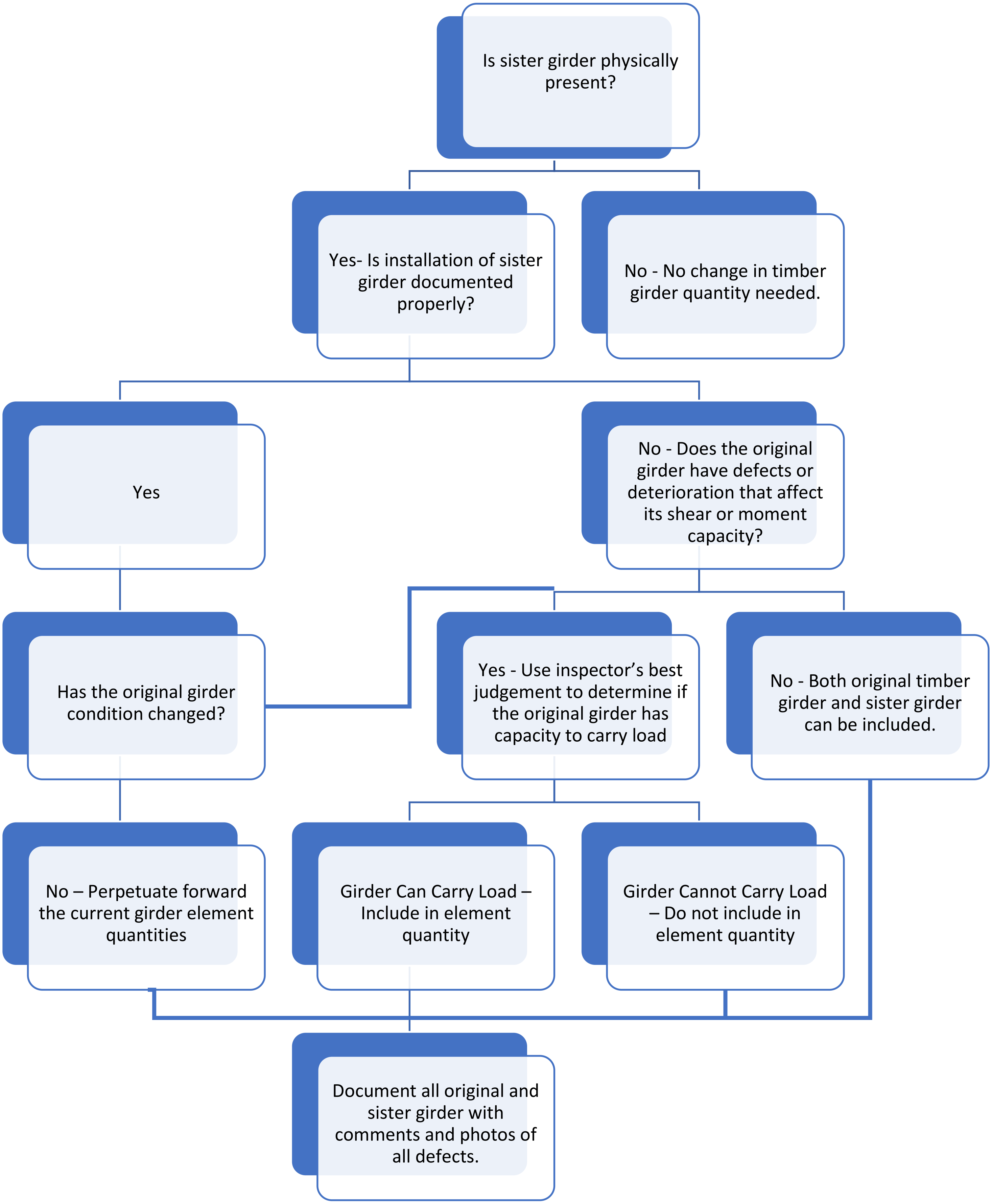
For example, if the original girder 7 has a sister girder on the right, the sister girder would have the name Girder 7 Right (G7R). The sister girder will have this name regardless of the condition of the original timber girder and whether the original girder is included in the element quantities. Right and left denotations are determined when looking in the direction the bridge is inventoried. See the *Bridge Numbering, Inventory Direction and Nomenclature* section of Chapter 3 for more information on bridge inventory direction and how to determine the direction.

6.4.5 Best Practices – Documentation of Sister Girders

- Measurement Sheets
  - Include all original and sister girders regardless of whether they are included in the element quantity or not.
  - When a new sister girder is added or observed, measure and update the bridge measurement forms.
  - For bridges with multiple sister girders, attach a plan view sketch that shows all existing girders (original and sister) and indicates whether they are included in the element quantities or not.
  - Numbering nomenclature should match guidance in this chapter.
- Inspection
  - Document the condition of all original girders (that have sister girders) and sister girders during every inspection with comments and photos.
  - Include photos and comments to describe the condition of defects and repairs made.
  - Document the defects on all original girders (with sister girders) that are not included in the timber girder element quantities with comments and photos.
    - Photos

   - Always include photos to show where a sister girder is located relative to the other girders in the span.

If accessible, prior to documenting girders with photos, physically mark the girder (using a paint pen, spray paint, chalk, etc...) with its number (e.g., S2-G4L, S1-G7, etc.) prior to taking photos, spray paint, chalk, etc.) with its number (e.g., S2-G4L, S1-G7, etc.) prior to taking photos.


Is sister girder physically present?
Yes- Is installation of sister girder documented properly?
No - No change in timber girder quantity needed.
Yes
No - Does the original girder have defects or deterioration that affect its shear or moment capacity?
Has the original girder condition changed?
Yes - Use inspector's best judgement to determine if the original girder has capacity to carry load
No - Both original timber girder and sister girder can be included.
No – Perpetuate forward the current girder element quantities
Girder Can Carry Load – Include in element quantity
Girder Cannot Carry Load – Do not include in element quantity
Document all original and sister girder with comments and photos of all defects.

6.5 MDT Inventory Items

This section documents other inventory items that are required to be collected and recorded for each bridge. Some items are collected and verified in the field, and some are administrative items collected from plans, design, or other non-field sources. See Appendix 4F for MDT Inventory Items that are the responsibility of the inspector. BrM will require collection of the following information specific to Montana.

MDT 007: Departmental Route

Guidance for this item will be available in a future version of the manual.

MDT 008: Depth of Cover (inches)

This field is used by the rating engineers to determine how much dead load should be added to a bridge. It is measured in inches from the top of the original deck surfacing to the top of the existing surface. See Figure 6.5-1 for illustrations of this measurement on different types of bridges. Use the measurement form provided on the MDT Bridge Inspection Teams channel. Consultants ask the Bridge Inspection Engineer for a copy.

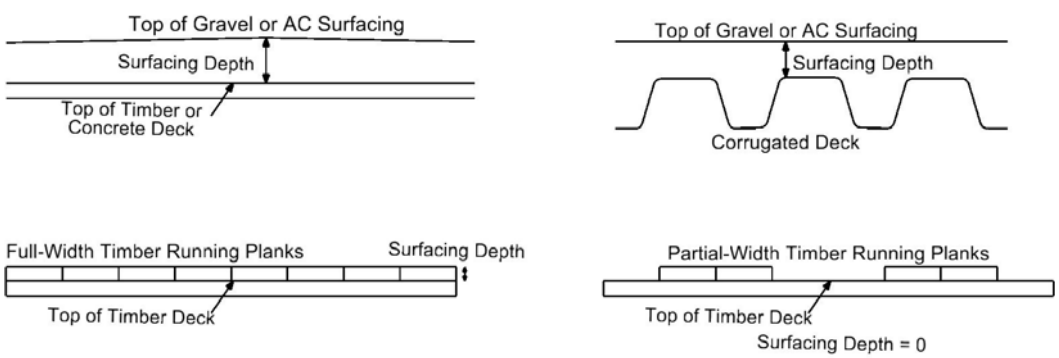


Figure 6.5-1 Depth of Cover Dimension on Various Structure Types

MDT 009: Detour Speed

Code the average speed in MPH of the detour route.

MDT 010: NSTM Inspection Details

This field is to show various Nonredundant Steel Tension Member configurations or fatigue-prone details. Select from a drop-down list of options.

MDT 014: Interchange Indicator

This field applies to the bridge itself, not the roadway. It is intended as a quick reference to determine possible detour solutions in the case that the bridge needs to be closed. Select 1 if it is a bridge carrying interstate traffic that has interchanges on both ends. Select 0 if there is no interchange near the bridge or the bridge does not carry an interstate route. If the bridge carries an interstate ramp, select 0.

MDT 015: Interstate Ramp Indicator

This field applies to bridges that carry an interstate ramp. It is coded at the bridge level, not the roadway level. Select 1 if it carries an interstate ramp or 0 if it does not.

MDT 017: MDT Original Construction Project Number

Enter the MDT construction project number the bridge was originally constructed under. If a large portion of the bridge was moved from another location to its current location (such as a truss), enter the project number for construction at its original location if available. If the original location project number is unknown, enter the project number for construction at its current location. Leave this field blank if the project number is unknown. If the bridge was constructed under a different entity (such as forest service or federal lands, include the Forest Service or Federal Lands project IDs.

MDT 018: MDT Original Construction Station

Enter the station where the bridge is located within the MDT construction project limits in its current location. This is usually listed on the bridge's General Layout plan sheet and is in the reconstruction project plans for bridges that have been moved. Leave this field blank if project information is unknown.

MDT 019: MDT Original Drawing Number

This field is for the drawing number the Bridge Bureau assigns to the General Layout plan sheet for bridges constructed under an MDT contract. It should not have a Q at the end. Drawing numbers with a Q at the end are for the quantity sheet, not the general layout.

When a large portion of the bridge was moved to its current location from another location, such as a truss, enter the drawing number for the truss at its original location. If that drawing number is not available, enter the drawing number for the bridge at its current location.

MDT 020: MDT Maintenance Division

Select the Maintenance Division from a drop-down list of options.

MDT 021: MDT UPN

This is for coding the Uniform Project Number (UPN) from the design plans for the structure.

When a large portion of the bridge was moved to its current location from another location, such as a truss, enter the UPN for the truss at its original location. If that drawing number is not available, enter the UPN for the bridge at its current location.

MDT 027: On/Off System

This indicates whether the bridge is on-system or off-system. Select from a drop-down list of options.

MDT 030: Posted Speed Limit (MPH)

This field is for the posted speed of vehicles traveling on the roadway.

MDT 031: Railroad Over/Underpass

Select whether the bridge is a railroad over or underpass from a drop-down list of options.

MDT 032: Railroad Owner

Select not applicable or the appropriate railroad from a drop-down list of options.

MDT 034: Request Review of Load Rating

Select “0” for No or select the appropriate choice from the drop-down list for Yes.

MDT 059: TE Route

Certain Urban, Secondary and Local routes are designated as TE routes and are used to transport missiles to various sites within a one-hundred-mile radius of Malmstrom Air Force Base in Great Falls. These routes are identified on county maps that are on file in the Bridge Management Section in Helena. FHWA guidelines require those structures between 8 and 20 feet in length also be inspected on these routes, including culverts as outlined in Section 1 of this manual. Selecting “1” from a drop-down list will record the bridge as being on a TE route and “0” will indicate not on a TE route.

MDT 074: Underwater Inspection Details

This field indicates if an Underwater (Diving) inspection is required. Bridge Management Headquarters will update this field. If an inspector thinks an underwater (Diving) inspection may be required, request review from Bridge Management Headquarters.

MDT 078: MDT Maintenance Section

This field is the MDT Maintenance Section with responsibility for maintenance of the bridge. There is a drop-down list to identify the various sections. Code it as “None” for bridges not maintained by MDT.

MDT 087: Decimal Mile Post

This is the milepost measured from the nearest upstation mile post sign. This is measured and entered by inspectors and is intended to help inspectors and other MDT personnel find the bridge in the field.

MDT 090: Climbing Inspection Required

This field indicates if a Climbing inspection is required. Bridge Headquarters will update this field. If an inspector thinks a Climbing inspection may be required, request review from Bridge Management Headquarters.

MDT 097: Plans in BrM?

Select “Y” if plans are in BrM or “N” if plans are not in BrM.

MDT 098: Shop Drawings in BrM

Select from a drop-down list of several options.

MDT 099: MDT Rehab Project Numbers

This field is for entering the project numbers for which the bridge has been rehabilitated.

MDT 100: MDT Rehab Stations

The station where the bridge is located within the MDT rehab construction project limits.

MDT 101: MDT Rehab UPNs

This is the Uniform Project Number (UPN) from design plans for the structure.

MDT 102: Years Rehabilitated

This field is for entering in the years in which the bridge has been rehabilitated.

MDT 103: MDT Rehab Drawing Numbers

This field is for the drawing number the Bridge Bureau assigns to the General Layout plan sheet for bridges constructed under an MDT contract.

MDT 113: Station Mile Post

This is the station milepost of the bridge measured from the closest upstation milepost sign.

MDT 115: MDT Administrative District

This is the administrative district where the bridge is located. Select from a dropdown list of options.

MDT 116: MDT Financial District

Select the appropriate Financial District from a dropdown list of options.

MDT 117: Border Bridge – Neighboring County Code

This is to code the neighboring county code. Select from a dropdown list of options.

MDT 118: Underwater Consultant

This is to code the underwater Consultant who performed the most recent underwater inspection. Bridge Management Headquarters updates this field.

MDT 119: Date Bridge Opened/Re-Opened to Traffic

This is the date a new bridge was opened to traffic, or the date a bridge that was closed for rehab purposes was reopened to traffic.

MDT 133: Bridge Within Reasonable Access of Interstate

This indicates whether the bridge is within 1 mile of an interstate ramp (as traveled along roadways). It helps load raters determine whether the bridge needs to be evaluated for the FAST Act Emergency Vehicles. Code “Y” for yes, “N” for no or “3” if not certain, from a drop-down list of options.

MDT 145: Bridge Inventory Direction

Select the log direction of the route being carried by the bridge from a drop-down list of options.

MDT 146: Bridge within a Reservation Boundary

If the bridge is within a reservation, then select the appropriate Reservation from a drop-down list of options. If it is not in a Reservation, then select “1” for No.

MDT 155: Year Reconstructed

Enter the year the structure was reconstructed or rehabilitated. This field may hold multiple years separated by commas.

MDT 156: Uncoated Weathering Steel

Code this field only for elements that are designed to be weathering steel. Review plans, girder stamps, or stickers to determine if girders are rustable steel or if they are bare steel with corrosion.

MDT 157: Trigger Flow

This field is entered and maintained by MDT Hydraulics.

MDT 158: Gage Site

This field is entered and maintained by MDT Hydraulics.

MDT 159: Real Time Gage Link

This field is entered and maintained by MDT Hydraulics.

MDT160: NWS Streamflow Forecast Link

This field is entered and maintained by MDT Hydraulics.

MDT161: QA Reviewer

Enter the full name of the person responsible for quality assurance review.

MDT162: Abutment Encroachment Floodplain

Probe and Wade: Does the Abutment encroach into the floodplain? Yes or No.

MDT 163: Amount of Channel Constriction

Probe and Wade: Rate amount of constriction due to Channel vegetation: Low, Medium, High.

MDT 164: Pier Nose Shape

Probe and Wade: Pier nose Shape: Round, Point, or Square.

MDT 165: Angle of Attack

Probe and Wade: Enter the angle at which the water flow hits the substructure units: 0-10deg, 11-20 deg, 21-30 deg, 31-40 deg, >40 deg.

MDT 166: Potential Debris Accumulation

Probe and Wade: Potential for debris and ice buildup: None, Low, Medium, High.

MDT 167: Pier Width

Probe and Wade: Pier width in feet: 3’, 3-4', 5-7', 8-9', >10’.

MDT 168: Bed Material

Probe and Wade: Bed Material: Bedrock, Boulder Cobble, Gravel, Sand, Silt/Clay.

MDT 169: Flow Impinging

Probe and Wade: on Abutment or Wingwall: Yes or No.

MDT 170: Bridge Location at Stream bend

Probe and Wade: Is Bridge located at a stream bend? Yes or No.

MDT 171: Constriction Channel Vegetation

Probe and Wade: Constriction due to channel vegetation: None, Low, Medium, High.

MDT 172: Number of Piers

Probe and Wade: Enter the number of piers or bents.

MDT 173: Bridge Near a Stream Confluence

Probe and Wade: Bridge near stream confluence? Yes, No.

MDT 174: Probe and Wade Comments

Probe and Wade: Remarks for Probe and Wade Inspection.

MDT 175: MDT Route System

This field is populated automatically through a link between MDT databases.

MDT 176: Temperature

Enter the average temperature at the time of the inspection.

MDT 177: Weather

Select weather conditions from drop down: Sunny, Cloudy, Rain, Snow, Night.

MDT 178: BNSF RR Flagger Required

If BNSF Flagger is required select Y, if not required select N.

MDT 179: MDT ID

This is the 5-digit ID number that designates the bridge location. It does not change when a bridge is replaced in the exact same location or very close to the location of the original bridge. See the Appendix 3C in Chapter 3 for more information.

MDT 180: Bridge Status

This designates the status of the bridge file. The options are listed below:

- 1 Inactive
- 3 Active
- 4 Proposed

MDT 181: Report Elements to FHWA

Checkbox indicates if Elements are reported to FHWA, Check box for all bridges.

MDT 182: Facility Carried

Enter the Name of the Facility carried by the structure, Example I-90.

MDT 183: Feature Intersected

Enter the name of the feature crossed by the bridge. Example: Beaver Creek 009.

MDT 184: Nickname

Enter this field if Inspectors or locals have a nickname for the bridge.

MDT 185: LRS Data as of Date

This field is populated automatically through a link between MDT databases.

MDT 186: Percent Truck Traffic

This field is automatically calculated using an interface between MDT databases.

MDT 187: Future AADT

This field is automatically calculated using an interface between MDT databases.

MDT 188: Year of Future AADT

This field is automatically calculated using an interface between MDT databases.

MDT 189: Railroad Bridge Agency Bridge ID

Guidance for this item will be available in a future version of the manual.

MDT 190: Date Entered

Input the Date the inspection was entered or entry began.

MDT 191: Entered By

Input the name of the person who entered the inspection.

MDT Items 192-207 are load rating items, and as such are described in the MDT Bridge Load Rating Manual. Information on how inspectors will use these items will be available in a guidance document to be incorporated into a future version of the manual.

Many MDT items were replaced with an SNBI item, removed from use, or moved to the MDT Load Rating Manual. See the following table for more information.

Replaced by SNBI Item or no longer used	Moved to Load Rating Manual (or new to load rating manual)
MDT001-006	MDT016
MDT011-013	MDT022
MDT023-029	MDT110
MDT033	
MDT035-058	
MDT060-073	
MDT075-077	
MDT079-086	
MDT088-089	

Replaced by SNBI Item or no longer used	Moved to Load Rating Manual (or new to load rating manual)
MDT091-096	
MDT104-109	
MDT111-112	
MDT114	
MDT120-132	
MDT134-144	
MDT147-148	

Chapter 6 Appendices

Appendix 6A – Transverse Cracks and Jump Cracks in Concrete Bridge Decks

Defect Discussion

Transverse Cracks & Jump Cracks

in Concrete Bridge Decks

Montana Department of Transportation

Bridge Bureau

August 2017

Background

In June of 2016, severe cracking was noted on two relatively new bridge decks, Superior Area Structures –MP 49.397 EB (MDT ID#s: 01358, 01359) and Lozeau-Tarkio Structures –MP 57.472 (MDT ID#s 01367, 01368). The bridges had full deck replacements in 2010 and 2011 respectively. The cracking in both bridges led to full depth holes in the decks. These holes developed relatively rapidly with very little warning compared to typical deck failures that happen on older decks with traditional spalls and delaminations. Additional bridges and bridge decks, many of which are relatively early in their design life, were identified with the same widespread transverse cracking patterns that have the potential to deteriorate and rapidly develop similar deck holes. These decks are being treated with a deck seal to "heal" the cracks and a polymer overlay to cap and protect the surface of the decks.

In April of 2017, Wiss, Janney, Elstner Associates, Inc. (WJE) completed a report on their investigation into these bridge decks. The report can be found at Forensic-Deck-Analysis-Report-2017-04-21. The bridge decks that have been identified with the same transverse cracking patterns are 1- to 9-year-old replacement decks over existing superstructures and on complete structure replacements of the same general vintage. The transverse cracks are appearing on both short-span and long-span structures, both steel and prestressed concrete, and include deck thicknesses ranging from 6½ to 9 inches.

Transverse Cracking

Transverse cracking describes cracks in the bridge deck that are along the transverse dimension of the bridge and occur with regular and repetitive spacing. Generally, the spacing ranges from about 2 to 8 feet between cracks. Transverse cracks are commonly the result of the bridge deck concrete trying to shrink while it cures, dries, and when the temperature decreases. As the concrete shrinks, its length is trying to decrease but is held in place by the connection to the girder. The more the concrete shrinks the more stress builds in the concrete until eventually a weak point will form a crack to relieve the stress and allow the change in length.

Transverse cracks can develop in the first few days after construction and some develop much later after the bridge deck is exposed to traffic. Transverse cracks are typically the full depth of the bridge deck, and most commonly occur directly over transverse reinforcing steel.

Jump Cracks

A jump crack is a semi-longitudinal crack that “jumps” or connects two closely spaced transverse cracks. Jump cracks generally form when two transverse cracks are closely spaced, usually 6 to 24 inches. Jump cracks are usually the full depth of the deck and may exhibit efflorescence. Jump cracks indicate an advanced stage of deterioration in the deck and are a sign that a hole may soon develop in the bridge deck.

Any delamination or spalling noted in the bridge decks will generally not be associated with the transverse cracking issues. Chaining will not give an indication as to an area that may be a problem, since the cracks are full depth and there is no traditional spalling associated with this issue.

The holes will develop in the areas where the jump cracks create “islands” of concrete. These problem areas occur where the pieces of concrete on either side of the cracks are “working” or moving against each other. This tends to create more cracks in the concrete island and even shears some of the reinforcement because of excessive movement around the cracks. Smaller chunks or “islands” of full depth concrete are then free to fall out, creating full depth deck holes.

One of the best indications of a problem area that is more advanced in its deterioration condition is a change in the efflorescence color on the soffit. If the cracks in and around and “island” of concrete are working and moving, there is usually evidence of excessive of leakage through the cracks and the efflorescence is a grayish color (from the grinding, which creates concrete powder) instead of the normal white in most of the other surrounding cracks.

Inspection

Inspect and document transverse cracks in the deck and any adjoining jump cracks in the concrete deck element transverse pattern cracking defect. Document the typical spacing between the transverse cracks, the typical widths of the transverse cracks, and check to see if the cracks are full depth. Note the size and locations of all jump crack areas and emphasize areas where heavy and/or grey efflorescence is present, especially if associated with heavy water staining and dense cracking or “islands”.

A defect for Concrete Deck, Transverse Pattern Cracking was previously added to BrM in 2023. This new defect is attached to the cracking defect for concrete decks, meaning it is always used in conjunction with the concrete deck cracking defect (just like the damage defect must be used in conjunction with another defect). The deck cracking defect can be used without the transverse pattern deck cracking defect if cracking does not meet the criteria for transverse pattern cracking, but the transverse pattern cracking defect can never be used without the deck cracking defect.

As always, document conditions with photos. Use the descriptions in the table below to determine the condition state of the defect:

Defect	**Concrete Deck, Transverse Pattern Cracking**
Condition State	**Description**
1	No or only short, random “jump” cracks noted.
2	Beginning “jump” cracks. Cracks may be full depth. Minor efflorescence with no gray staining.
3	Narrow jump cracks with concrete islands likely. Most transverse cracks full depth. Efflorescence is present but little to no gray efflorescence.
4	Full depth transverse cracking. Full depth jump cracks, resulting in concrete islands. Possible raveling of closely spaced cracks, especially in “island” areas. Heavy gray colored efflorescence present. Water staining evident from leakage through cracks, especially in island areas. Future deck holes likely or holes repaired by Maintenance are present.

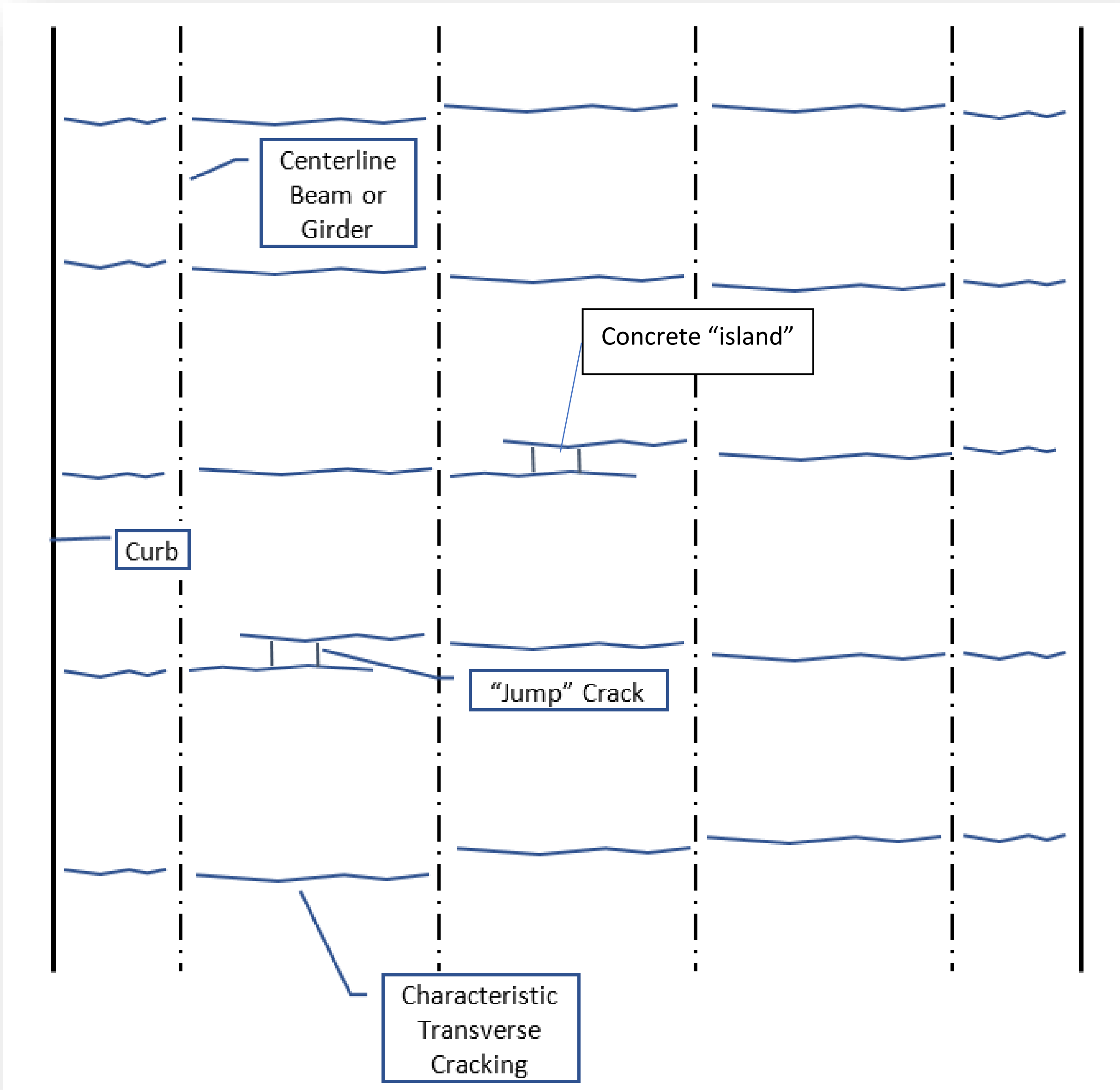


Figure 1. Sketch of Transverse and Jump Cracks

Figure 2. Transverse Cracks in Bridge Deck

Figure 3. Typical Transverse Cracks Seen from Underneath.

Figure 4 Holes in Bridge Deck. Note the longitudinal jump cracks that create the rectangular “island” of concrete. The “island” continued to crack until full depth chunk or “island” fell out, creating the hole.

Figure 5. Same hole as Fig. 4 as seen from underneath. (Note the heavy staining on the soffit and girders from leakage in the cracks around the hole and in nearby transverse cracks and the jump cracks with staining beginning at another location not far from the hole. Also note that there are no jump cracks in the adjacent bay.)

Figure 6. Example of Heavy staining from water leakage. (Note the contrast between the gray efflorescence in the upper 2 transverse cracks (evidence of concrete movement around crack and heavy water leakage and the white efflorescence in the bottom transverse cracks. Also note the longitudinal jump crack with light white efflorescence.)

Figure 7. When to not use jump cracking defect. Use the deck cracking defect only. Transverse cracking is present but sporadic. Note the wide crack spacing, the lack of staining, and no longitudinal jump cracks. All efflorescence is white.

Figure 8. Example of Condition State 2. Note possible beginning jump cracks.

Figure 9. Example of Condition State 3. Note the tight spacing (12” to 18”) of some of the transverse cracks, along with evidence of heavy leakage and some gray efflorescence. Also, small jump cracks are evident.

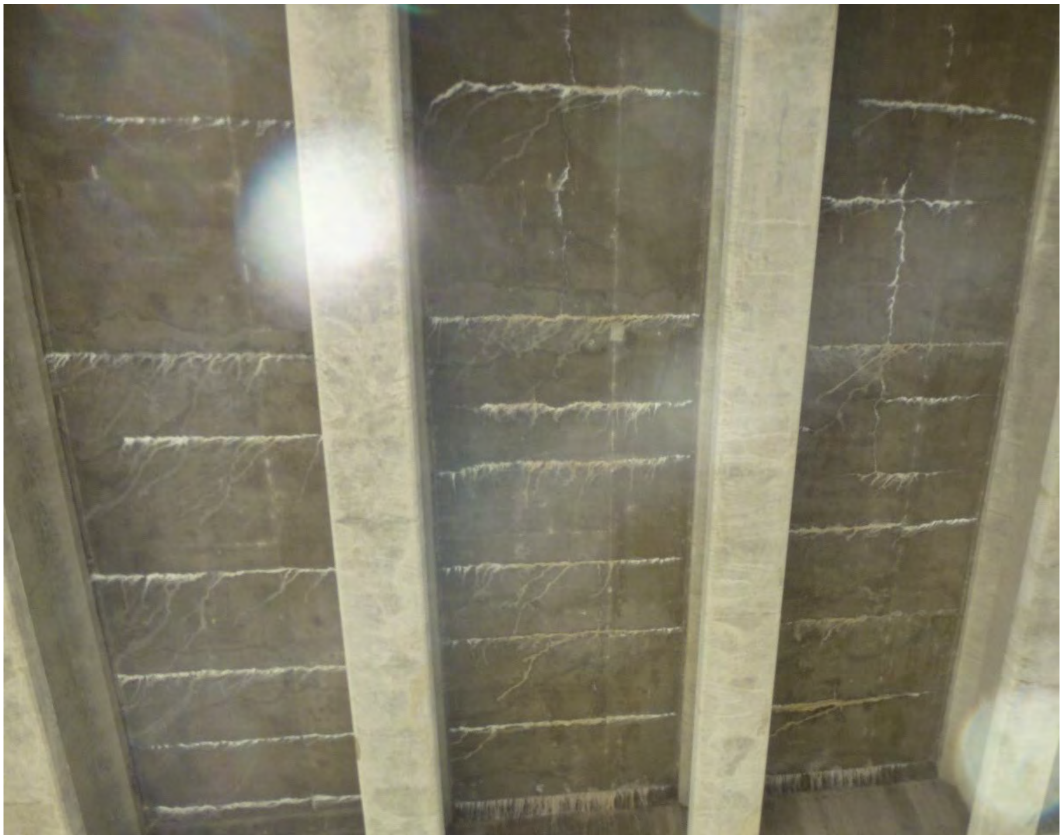


Figure 10. Example of Condition State 3. Tight spacing, jump cracks, some light staining from leakage, and some gray efflorescence.

Figure 11. Example of Condition State 4. Note the tight spacing, multiple jump cracks (some creating the concrete "islands"), very heavy gray staining and efflorescence.

Figure 12. Example of Condition State 4. Tight spacing, jump cracks, “islands,” grey colored efflorescence present, very heavy water staining, repaired hole.

Appendix 6B – Bridge Rail Protective Coating Quantity Aid

MDT Standard Bridge Rail Protective Coating Quantities

W-Shaped Rails:	SF/LF
- Single W-shaped rail and timber or concrete posts	2.5
- Single W-shaped rail, steel posts; no add'l components (SBBR)	3.5
- Single W-shaped rail, steel posts and 4" diameter handrail (SBR T4)	5.0
- Single W-shaped rail, steel posts and (2) 4" x 3" backer tubes (T-101)	5.5
- Single W-shaped rail, steel posts and (2) 3.5" diameter backer tubes (SBR T8)	5.5
Square Tubular Rails	
- Single 5" x 5" tubular rail and steel posts anchored to curb (SBR T5)	2.5
- Two 4" x 4" tubular rails and steel posts anchored to curb(SBR T6)	4.0
Rectangular Tubular Rails:	
- Two steel 6" wide rails and steel posts anchored to curb (W740, W830)	4.0
Picketed Pedestrian rails	
- 6" C-shape top/bottom rails, 2" x 2" angle pickets and steel posts (SBR T2/T3)	6.5
- Triple 4" x 4" tubular rails, 1.5" x 3/4" C-shaped pickets and steel posts (SBR T7)	8.0

Note: Multiply the bridge rail NBE original quantity x the proper factor noted above to calculate the square footage for the bridge railing protective coating. Use judgment for bridge railing types not listed above.

Chapter 7– Waterway Bridge Inspection

7.1 Background and Inspection Determination

7.1.1 Waterway Inspection Purpose

The purpose of Waterway inspection at a bridge is twofold:

1. To assess the condition of substructure units under water
2. To determine the bridge's susceptibility to scour

7.2 Waterway Inspection Determination

A bridge with substructure elements in water that is more than two feet deep year-round requires waterway inspection.

Bridges whose substructure units at some times are dry or in very shallow water (making a full inspection possible without the use of special equipment) do not require a waterway inspection unless SNBI item B.AP.03 is coded C or D. This includes single-span bridges where the abutments are not in the water.

If SNBI item B.AP.03 is coded C or D, regardless of water at the time of the inspection, cross-sections are required. This means that all bridges with substructure elements in the water, with SNBI item B.AP.03 coded as C or D require waterway inspection.

If Element 900, Scour, has been added to the bridge, waterway inspection is required.

If any undermining of the abutments is present, regardless of whether they are in the water when the inspection is done, waterway inspection is required.

Once it has been determined that a bridge requires waterway inspection, it will be placed in one of two categories:

1. Routine Probe and Wade Inspection
2. Underwater Diving Inspection

The first determination an inspector must make is whether the bridge requires waterway inspection. See the guidelines above to determine whether a bridge requires waterway inspection. If a bridge does not meet the requirements above for waterway inspection, the inspector may still do waterway inspections on the bridge if they are deemed necessary.

Keep in mind the time of year you are looking at the bridge, and what it may look like during a different time of the year.

Example: you’re looking at a bridge in March trying to determine whether it requires waterway inspection. The substructure units are in 3 to 4 feet of clear water, and for that reason you feel it requires a Probe and Wade Inspection. Consider the possibility that in October or November, a lower water level will allow complete visual access to all portions of the bridge. If – in your judgment – this is the case, the bridge does not require waterway inspection. The routine inspection, however, MUST be conducted when the water is low and all of the substructure units can be visually inspected.

Next, the inspector needs to determine what kind of waterway inspection is required. On bridges where the substructure units remain under water year-round, the inspector must determine whether at some time it will be possible to adequately inspect all underwater portions using waders. If the answer is no, the inspector will notify the Bridge Management Section. Bridge Management Section personnel will review the recommendation and change the waterway inspection requirements as needed.

MDT 074 is to be coded in BrM based off the waterway determination. Code N if not required, code 1- Probe and Wade, or code 2- Diver. Item B.IR.03 should also be coded "Y" if an underwater inspection is required.

Additional resources for waterway inspection are the NHI courses and handbooks, *Evaluating Scour at Bridges* and *Stream Stability at Highway Structures.* These resources include in-depth instruction for waterway inspection.

7.3 Routine Probe and Wade Inspection

Bridges that require waterway inspection and can be inspected by personnel using special equipment (waders or probe), qualify for Probe and Wade Inspection.

The inspector must be able to fully evaluate the condition of the substructure unit using waders or working from a boat. To accomplish this, the water must be clear enough to allow a thorough visual examination of all substructure units. The inspector must be able to perform any cleaning which may be necessary to access all portions of each substructure unit.

If the water is not clear enough for a full visual inspection, it must be shallow enough to allow inspectors to feel the condition of all substructure units and determine the possibility of undermining. Bridges requiring Probe and Wade will be inspected in combination with the Routine inspection at 24-month intervals. If it is decided that the bridge requires more intensive monitoring, adjustments to the frequency of these inspections will be made using Special Inspections. The Other Special Inspection types (1, 2, or 3) should be used for decreased frequency for Probe and Wade inspection and Cross sections. This decreased frequency Special Inspection should be added following the steps included in the Special Inspection guidance (Chapter 4, Section 4.1.8).

7.3.1 Performing Routine Probe and Wade Inspections

In the case of a pile cap or spread footing, the inspector will indicate to what extent, if any, the footings are exposed or undermined. The inspector will also record the condition of the underwater substructure elements and note the depth of any localized scour.

In the case of driven piles or drilled shafts, the inspector will determine the condition of the underwater substructure elements and note the depth of any localized scour at the piles or shafts.

Probe and Wade Inspection – Streamflow Condition

The Probe and Wade Inspection form in BrM Inspection Condition will be filled out to indicate the condition of the items listed in the form. Fields to fill out include inventory items such as the number of piers, pier width, and pier nose shape; and inspection items such as the angle of attack, whether flow is impinging on the abutment or wingwall, etc. The inspector may choose to use sketches to communicate streamflow conditions. Sketches may also be used to describe size and location of scour.

Probe and Wade Inspection – Element Condition

The condition of elements that are underwater, such as piles and footings, will be noted and entered into the inspection Condition.

Probe and Wade Inspection – Cross-Sections

If a waterway Inspection is required, cross-sections are required to be taken at a 48-month frequency. These are scheduled in BrM as a cross-section inspection type. Cross-sections are to be taken at the upstream face of the Bridge. Cross-sections may be taken farther upstream or downstream of the upstream face of the bridge as needed. For bridges with scour countermeasures not visible for inspection, take cross sections at the bridge face during every inspection to help determine if the countermeasure is in place and the degree of degradation, aggradation, and/or channel migration. The intent is not to take cross-sections every inspection due to riprap, but to cross-section other countermeasures that may be buried beneath aggradation or are prone to settlement. If a visible countermeasure shows signs of settlement or movement (such as concrete mattresses), take cross-sections during every inspection.

The bridge structure must also be plotted in BrM as a reference for comparison with cross-sections. This structure plot should be added to the Cross-Sections module in BrM at the time that a bridge is added to the inventory. Once this structure detail has been added it should be updated if any rehab or reconstruction work has changed the substructure.

Baseline Cross-Sections

If a waterway inspection is not required, but the structure crosses any form of waterway (excluding irrigation canals), one set of baseline cross-sections must be taken. Baseline cross-sections are necessary to compare current conditions to the original profile. For structures with plans including a plan profile, cross-sections are not required as the profile plots the baseline cross-section. For existing bridges without a plan profile and without a baseline cross-section, these should be taken one-time during the current inspection. Stream cross-sections should be taken and entered into BrM using the procedures described above for cross-sections. Structures requiring a baseline cross-section only must have an updated baseline cross-section scheduled at a 20-year interval or after any large hydraulic event.

7.4 Underwater Diving Inspection

Bridges that require waterway inspection but cannot be inspected using Probe and Wade Inspection methods require inspection by a diver. Diving inspections are performed by consultants under a contract managed by the Bridge Management Section in Headquarters. Diving inspections include stream cross-sections taken by the consultant and entered into BrM using the procedures as described above for cross-sections.

Specific inspection procedures are required for each Underwater Dive inspection. These are to be included in the BrM Procedures Module. These should also be included in the Inspection summary document.

The coding for Item B.C.03 should be updated when the Substructure rating is affected by changes in condition identified during an Underwater Diving Inspection. Comments should be made when the coding for Substructure is updated.

Underwater Dive Inspections will be completed at a 60-month inspection interval. If it is decided that the bridge requires more intensive monitoring, adjustments to the frequency of these inspections will be made using Special inspections. Special Underwater Diving inspections should be added using the Underwater Special Inspection type. This decreased frequency Special Inspection should be added following the steps included in the Special Inspection guidance (Chapter 4, Section 4.1.8). The reasons for this Special Underwater Inspection and the specific detail of this inspection should be included in the inspection procedures.

7.5 Waterway Inspection Photos

As is the case with any inspection, photographs will be used to document the findings. These photos must include:

- Photo looking upstream showing both banks.
- Photo looking downstream showing both banks.
- The following are also required when applicable:
  - Photo of signs of inadequate waterway area
  - Photo of ice jams or flows
  - Photo of debris
  - Photo of condition of the riprap if deteriorated
  - Photo of cross fences or channel obstructions
  - Photo including rod or tape for scale if significant scour is present

Chapter 8— Agency Defined Elements

Chapter 8 includes all current MDT Agency Defined Elements (ADEs). ADEs are provided in standard MBEI coding table format for use in identifying and condition state coding of all relevant Agency Defined Elements for each bridge.

8.1 Detailed Element Descriptions

This Chapter contains all of MDT's ADEs to track the condition of different types of reinforcement and submerged and miscellaneous elements. The elements are organized by major groupings such as Decks and Slabs, Superstructure, Substructure, Other and Off-Bridge elements. Each element has a detailed element description which is broken down into three subsections:

1. **Description**—Detailed identification and classification of the element, including units of measurement, and guidelines on how to collect the quantity of the element in a consistent manner.
2. **Condition State Definition Table**—Defect descriptions and severity, with guidelines to the inspector for determining defect severity.
3. **Element Commentary**—Additional considerations for the inspector to be aware of during data collection.

For condition coding guidance for the National Bridge Elements (NBEs) and the Bridge Management Elements (BMEs) reference and use the latest version of the AASHTO Manual for Bridge Element Inspection (MBEI). These AASHTO NBE and BME tables were previously provided in Chapters 3 through 6 of this manual; however, because they are updated regularly by AASHTO and should not be changed by owners, they are no longer included in this manual.

8.2 Decks, Slabs, Top Flanges and Related ADEs

8.2.1 Element 990—Concrete Reinforcing Protective System

Description: All types of metallic reinforcing other than carbon steel

Classification: ADE **Units of Measurement**: ft^2

Quantity Calculation: Include the entire surface area of the protected element (deck or slab)

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Effectiveness—Protective System (3600)	Fully effective.	Substantially effective.	Limited effectiveness.	The protective system has failed or is no longer effective.
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This protection system element is intended to capture situations where the concrete element may be expected to deteriorate at a rate that is slower than unprotected situations. This protective system includes metallic systems that do not include standard carbon steel reinforcing. Solid stainless steel, aluminum, or other metallic systems are included in this element. Wearing surfaces are addressed under the appropriate wearing surface element and not this element.

8.2.2 Element 991—Corrosion-Resistant Reinforcing Protective System

Description: All types of non-metallic reinforcing systems

Classification: ADE **Units of Measurement:** ft^2

Quantity Calculation: Include the entire surface area of the protected element (deck or slab)

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Effectiveness—Protective System (3600)	Fully effective.	Substantially effective.	Limited effectiveness.	The protective system has failed or is no longer effective.
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This protection system element is intended to capture situations where the concrete element may be expected to deteriorate at a rate that is slower than unprotected situations. This protective system includes non-metallic reinforcing systems such as glass, basalt, or carbon fiber. Wearing surfaces are addressed under the appropriate wearing surface element and not this element.

8.3 Superstructure ADEs

8.3.1 Element 810—Steel Transverse Girder

Description: All steel girders, not including floor beams that are mounted transversely on columns and support longitudinal girders, regardless of protective system.

Classification: ADE **Units of Measurement**: ft

Quantity Calculation: Sum of all the lengths of each transverse rolled, built-up or box girder assembly, measured along the skew.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion are present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

Condition evaluation for this element includes all visible faces of the girder(s). This element is considered a nonredundant steel tension member.

8.3.2 Element 811—Prestressed Concrete Transverse Girder

Description: All pretensioned or post-tensioned concrete girders that are not concrete caps and are mounted transversely on columns and support longitudinal girders, regardless of protective system.

Classification: ADE **Units of Measurement**: ft

Quantity Calculation: Sum of all lengths of each girder measured along the skew.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Exposed Prestressing (1100)	None.	Present without section loss.	Present with section loss but does not warrant structural review.	
Cracking (PSC) (1110)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The inspector should use judgment when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, prestressed concrete cracks less than 0.004 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.004 to 0.009 inches can be considered moderate, and cracks greater than 0.009 inches can be considered wide.

8.3.3 Element 812—Other Transverse Girder

Description: All other material girders that are mounted transversely on columns and support longitudinal girders, regardless of protection system.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Sum of all the lengths of each girder.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion are present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched are that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	

Defects	Condition States 1 GOOD	2 FAIR	3 POOR	4 SEVERE
Deterioration (Other) (1220)	None.	Initiated breakdown or deterioration.	Significant deterioration or breakdown but does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The other material open girder is intended for transverse girders constructed of composite materials, or other materials that cannot be classified using any other defined transverse girder element.

8.3.4 Element 815—Steel Railroad Car Girder

Description: All steel railroad car girders regardless of protective system.

Classification: ADE **Units of Measurement**: ft

Quantity Calculation: Sum of all the lengths of each railroad car girder.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

Condition evaluation for this element includes the car floor (deck) condition as well as the structural components underneath that comprise the total girder construction.

8.3.5 Element 820—Steel Truss Vertical Cross Frame

Description: Steel cross frame elements that are sway frames on through trusses, regardless of protective system.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Sum of all the lengths of each cross frame measured along the skew.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion are present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This element may be comprised of single or multiple, built-up steel sections for each cross frame. There will generally be a cross frame at every panel point as well as portal frames. Sway bracing between the cross frames is not included in the quantity.

8.3.6 Element 821—Steel Curved Girder Diaphragm

Description: All diaphragms on a steel curved girder system regardless of protective system.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Sum of all the lengths of each diaphragm measured perpendicular to the radius of the curved girder or along the skew as required.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion are present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This element may be a solid rolled section or a built-up cross frame section. Condition evaluation for this element includes the web face and the top and bottom faces of the flange for the rolled sections or all faces of the cross-frame components, including the connection plates.

8.3.7 Element 825—Transverse Post Tensioning Anchor

Description: All exposed transverse post tensioning anchor ends in prestressed concrete box and slab sections, timber slabs and post tensioned concrete such as prestressed concrete transverse girders and decks regardless of protective system.

Classification: ADE **Units of Measurement**: each

Quantity Calculation: The sum of individual anchor ends.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

None.

8.4 Substructure ADEs

8.4.1 Element 855—Timber Pile Cap/Footing

Description: Timber pile caps/footings that may be placed under one or more piles for element stabilization. To evaluate timber pile caps/footings under the water surface use Element 271, Submerged Pile Cap/Footing. For all timber pile caps/footings above the water surface regardless of protective systems.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Sum of the length of the pile cap/footing measured along the skew angle of the pier or bent.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion are present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Decay/Section Loss (1140)	None.	Affects less than 10% of the member section.	Affects 10% or more of the member but does not warrant structural review.	
Check/Shake (1150)	Surface penetration less than 5% of the member thickness regardless of location.	Penetrates 5%–50% of the thickness of the member and not in a tension zone.	Penetrates more than 50% of the thickness of the member or more than 5% of the member thickness in a tension zone. Does not warrant structural review.	
Crack (Timber) (1160)	None.	Crack that has been arrested through effective measures.	Identified crack that is not arrested but does not require structural review.	
Split/Delamination (Timber) (1170)	None.	Length less than the member depth or arrested with effective actions taken to mitigate.	Length equal to or greater than the member depth but does not require structural review.	

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Abrasion/Wear (Timber) (1180)	None or no measurable section loss.	Section loss less than 10% of the member thickness.	Section loss 10% or more of the member thickness but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
Scour (6000)	None	Exists within tolerable limits or has been arrested with effective countermeasures.	Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

None.

8.4.2 Element 860—Submerged Steel Column

Description: All steel columns accessible for inspection under the water surface at the time of inspection regardless of protective system.

Classification: ADE **Units of Measurement**: each

Quantity Calculation: Sum of the number of submerged columns that are accessible for inspection.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None.	Crack that has self-arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack that is not arrested by does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
Scour (6000)	None.	Exists within tolerable limits or has been arrested with effective countermeasures.	Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review	

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This element shall only be included in Underwater Inspections.

8.4.3 Element 861—Submerged Prestressed Concrete Column

Description: Prestressed concrete columns that are accessible for inspection that are under the water surface at the time of inspection regardless of protective system.

Classification: ADE **Units of Measurement:** each

Quantity Calculation: Sum of the number of submerged columns accessible for inspection.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Delamination/Spall / Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Exposed Prestressing (1100)	None.	Present without section loss.	Present with section loss but does not warrant structural review.	
Cracking (PSC) (1110)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Abrasion/Wear (PSC/RC) (1190)	No abrasion or wearing.	Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	

Defects	Condition States 1 GOOD	2 FAIR	3 POOR	4 SEVERE
Scour (6000)	None.	Exists within tolerable limits or has been arrested with effective countermeasures.	Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This element shall only be included in Underwater Inspections.

The inspector should use judgment when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.004 inches can be considered insignificant, and a defect is not warranted. Cracks ranging from 0.004 to 0.009 inches can be considered moderate, and cracks greater than 0.009 inches can be considered wide.

8.4.4 Element 862—Submerged Reinforced Concrete Column

Description: All reinforced concrete columns accessible for inspection that are under the water surface at the time of inspection regardless of protective system.

Classification: ADE **Units of Measurement:** each

Quantity Calculation: Sum of the submerged columns accessible for inspection.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Delamination/Spall / Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Abrasion/Wear (PSC/RC) (1190)	No abrasion or wearing.	Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Scour (6000)	None.	Exists within tolerable limits or has been arrested with effective countermeasures.	Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This element shall only be included in Underwater Inspections.

The inspector should use judgment when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide

8.4.5 Element 863—Submerged Timber Column

Description: All timber columns accessible for inspection that are under the water surface at the time of inspection regardless of protective system.

Classification: ADE **Units of Measurement:** each

Quantity Calculation: Number of columns accessible for inspection.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Decay/Section Loss (1140)	None.	Affects less than 10% of the member section.	Affects 10% or more of the member but does not warrant structural review.	
Check/Shake (1150)	Surface penetration less than 5% of the member thickness regardless of location.	Penetrates 5%–50% of the thickness of the member and not in a tension zone.	Penetrates more than 50% of the thickness of the member or more than 5% of the member thickness in a tension zone. Does not warrant structural review.	
Crack (Timber) (1160)	None.	Crack that has been arrested through effective measures.	Identified crack that is not arrested but does not require structural review.	
Split/Delamination (Timber) (1170)	None.	Length less than the member depth or arrested with effective actions taken to mitigate.	Length equal to or greater than the member depth but does not require structural review.	
Abrasion/Wear (Timber) (1180)	None or no measurable section loss.	Section loss less than 10% of the member thickness.	Section loss 10% or more of the member thickness but does not warrant structural review.	

Defects	Condition States 1 GOOD	2 FAIR	3 POOR	4 SEVERE
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Scour (6000)	None.	Exists within tolerable limits or has been arrested with effective countermeasures.	Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4under the appropriate material defect entry.

Element Commentary

This element shall only be included in Underwater Inspections.

8.4.6 Element 864—Other Submerged Column

Description: All other material columns accessible for inspection that are under the water surface at the time of inspection regardless of protective system.

Classification: ADE **Units of Measurement:** each

Quantity Calculation: Sum of the number of columns accessible for inspection.

Condition State Definitions

Defects	Condition States 1 GOOD	2 FAIR	3 POOR	4 SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None.	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched are that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) Cracking.	Wide cracks or heavy pattern (map) cracking.	

Defects	Condition States 1 GOOD	Condition States 2 FAIR	Condition States 3 POOR	Condition States 4 SEVERE
Deterioration (Other) (1220)	None.	Initiated breakdown or deterioration.	Significant deterioration or breakdown but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Scour (6000)	None.	Exists within tolerable limits or has been arrested with effective countermeasures.	Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This element shall only be included in Underwater Inspections.

The other material column is intended for columns constructed of composite materials, or other materials that cannot be classified using any other defined column elements.

8.4.7 Element 870—Submerged Reinforced Concrete Pier Wall

Description: Reinforced concrete pier walls accessible for inspection that are under the water surface at the time of inspection regardless of protective systems.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Sum of the lengths of the pier walls measured along the skew angle and accessible for inspection.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Abrasion/Wear (PSC/RC) (1190)	No abrasion or wearing.	Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	

Defects	Condition States 1 GOOD	2 FAIR	3 POOR	4 SEVERE
Scour (6000)	None.	Exists within tolerable limits or has been arrested with effective countermeasures.	Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This element shall only be included in Underwater Inspections.

The inspector should use judgment when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

8.4.8 Element 871—Submerged Timber Pier Wall

Description: Those timber pier walls that include pile, timber sheet material, and filler. For all pier walls accessible for inspection that are under the water surface at the time of inspection, regardless of protective systems.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Sum of the length of the pier walls accessible for inspection measured along the skew angle.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion are present, but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Decay/Section Loss (1140)	None.	Affects less than 10% of the member section.	Affects 10% or more of the member but does not warrant structural review.	
Check/Shake (1150)	Surface penetration less than 5% of the member thickness regardless of location.	Penetrates 5%–50% of the thickness of the member and not in a tension zone.	Penetrates more than 50% of the thickness of the member or more than 5% of the member thickness in a tension zone. Does not warrant structural review.	
Crack (Timber) (1160)	None.	Crack that has been arrested through effective measures.	Identified crack that is not arrested but does not require structural review.	
Split/Delamination (Timber) (1170)	None.	Length less than the member depth or arrested with effective actions taken to mitigate.	Length equal to or greater than the member depth but does not require structural review.	

Defects	Condition States 1 GOOD	2 FAIR	3 POOR	4 SEVERE
Abrasion/Wear (Timber) (1180)	None or no measurable section loss.	Section loss less than 10% of the member thickness.	Section loss 10% or more of the member thickness but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
Scour (6000)	None.	Exists within tolerable limits or has been arrested with effective countermeasures.	Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This element shall only be included in Underwater Inspections.

8.4.9 Element 872—Submerged Masonry Pier Wall

Description: Those pier walls constructed of block or stone. The block or stone may be placed with or without mortar. For all masonry pier walls accessible for inspection that are under the water surface at the time of inspection, regardless of protective systems.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Sum of the wall lengths accessible for inspection measured along the skew angle.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Efflorescence/Rust Staining (1120) Patched Area (1080)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Mortar Breakdown (Masonry) (1610)	None.	Cracking or voids in less than 10% of joints.	Cracking or voids in 10% or more of the joints.	
Split/Spall (Masonry) (1620)	None.	Block or stone has split or spalled with no shifting.	Block or stone has split or spalled with shifting but does not warrant a structural review.	
Patched Area (Masonry) (1630)	None.	Sound patch.	Unsound patch.	
Masonry Displacement (1640)	None.	Block or stone has shifted slightly out of alignment.	Block or stone has shifted significantly out of alignment or is missing but does not warrant structural review.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
Scour (6000)	None.	Exists within tolerable limits or has been arrested with effective countermeasures.	Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.	

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This element shall only be included in Underwater Inspections.

8.4.10 Element 873—Other Submerged Pier Wall

Description: Those pier walls constructed of other materials accessible for inspection that are under the water surface at the time of inspection regardless of protective systems.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Sum of the number of the pier walls accessible for inspection measured along the skew.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched are that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking	Width greater than 0.05 in. or spacing of less than 1 ft.	The condition warrants a structural review to determine the effect on strength or

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Deterioration (Other) (1220)	None.	Initiated breakdown or deterioration.	Significant deterioration or breakdown but does not warrant structural review.	serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
Scour (6000)	None.	Exists within tolerable limits or has been arrested with effective countermeasures.	Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This element shall only be included in Underwater Inspections.

This element should be used for pier walls constructed of other materials not otherwise defined.

8.4.11 Element 880—Submerged Steel Pile

Description: Steel piles that are accessible for inspection, including piles exposed from erosion or scour and piles accessible during an underwater inspection. For all steel piles under the water surface at the time of inspection regardless of protective system.

Classification: ADE **Units of Measurement:** each

Quantity Calculation: Sum of the number of piles accessible for inspection.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None.	Crack that has self-arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack that is not arrested by does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
Scour (6000)	None.	Exists within tolerable limits or has been arrested with effective countermeasures.	Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.	

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This element shall only be included in Underwater Inspections.

8.4.12 Element 881—Submerged Prestressed Concrete Pile

Description: Prestressed concrete piles that are accessible for inspection below the water surface at the time of inspection including piles exposed from erosion or scour. For all submerged prestressed concrete piles regardless of protective system.

Classification: ADE **Units of Measurement:** each

Quantity Calculation: Sum of the number of piles accessible for inspection below the water surface.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Exposed Prestressing (1100)	None.	Present without section loss.	Present with section loss but does not warrant structural review.	
Cracking (PSC) (1110)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide Cracks or heavy pattern (map) cracking.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Abrasion/Wear (PSC/RC) (1190)	No abrasion or wearing.	Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.	

<table>
<tr><th rowspan="3">Defects</th><th colspan="4">Condition States</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><th>GOOD</th><th>FAIR</th><th>POOR</th><th>SEVERE</th></tr>
<tr><td>Settlement (4000)</td><td>None.</td><td>Exists within tolerable limits or arrested with no observed structural distress.</td><td>Exceeds tolerable limits but does not warrant structural review.</td><td rowspan="2">The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.</td></tr>
<tr><td>Scour (6000)</td><td>None.</td><td>Exists within tolerable limits or has been arrested with effective countermeasures.</td><td>Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.</td></tr>
<tr><td>Damage (7000)</td><td>Not applicable.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.</td></tr>
</table>

Element Commentary

This element shall only be included in Underwater Inspections.

The inspector should use judgment when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.004 inches can be considered insignificant, and a defect is not warranted. Cracks ranging from 0.004 to 0.009 inches can be considered moderate, and cracks greater than 0.009 inches can be considered wide.

8.4.13 Element 882—Submerged Reinforced Concrete Pile

Description: Reinforced concrete piles that are accessible for inspection below the water surface at the time of inspection including piles exposed from erosion or scour. For all reinforced concrete piles regardless of protective system.

Classification: ADE **Units of Measurement:** each

Quantity Calculation: Sum of the number of piles accessible for inspection under the water surface.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide Cracks or heavy pattern (map) cracking.	
Abrasion/Wear (PSC/RC) (1190)	No abrasion or wearing.	Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	

Defects	Condition States 1 GOOD	2 FAIR	3 POOR	4 SEVERE
Scour (6000)	None.	Exists within tolerable limits or has been arrested with effective countermeasures.	Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Damage (7000	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This element shall only be included in Underwater Inspections.

The inspector should use judgment when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

8.4.14 Element 883—Submerged Timber Pile

Description: Timber piles that are accessible for inspection under the water surface at the time of inspection, including piles exposed from erosion or scour. For all submerged timber piles regardless of protective system.

Classification: ADE **Units of Measurement:** each

Quantity Calculation: Sum of the number of piles under the water surface accessible for inspection.

Condition State Definitions

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Decay/Section Loss (1140)	None.	Affects less than 10% of the member section.	Affects 10% or more of the member but does not warrant structural review.	
Check/Shake (1150)	Surface penetration less than 5% of the member thickness regardless of location.	Penetrates 5%–50% of the thickness of the member and not in a tension zone.	Penetrates more than 50% of the thickness of the member or more than 5% of the member thickness in a tension zone. Does not warrant structural review.	
Crack (Timber) (1160)	None.	Crack that has been arrested through effective measures.	Identified crack that is not arrested but does not require structural review.	
Split/Delamination (Timber) (1170)	None.	Length less than the member depth or arrested with effective actions taken to mitigate.	Length equal to or greater than the member depth but does not require structural review.	
Abrasion/Wear (Timber) (1180)	None or no measurable section loss.	Section loss less than 10% of the member thickness.	Section loss 10% or more of the member thickness but does not warrant structural review.	

<table>
<tr><th rowspan="3">Defects</th><th colspan="4">Condition States</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><th>GOOD</th><th>FAIR</th><th>POOR</th><th>SEVERE</th></tr>
<tr><td>Settlement (4000)</td><td>None.</td><td>Exists within tolerable limits or arrested with no observed structural distress.</td><td>Exceeds tolerable limits but does not warrant structural review.</td><td rowspan="2">The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.</td></tr>
<tr><td>Scour (6000)</td><td>None.</td><td>Exists within tolerable limits or has been arrested with effective countermeasures.</td><td>Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.</td></tr>
<tr><td>Damage (7000)</td><td>Not applicable.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.</td></tr>
</table>

Element Commentary

This element shall only be included in Underwater Inspections.

8.4.15 Element 884—Other Submerged Pile

Description: Other material piles that are accessible for inspection below the water surface at the time of inspection, including piles exposed from scour. For all other material piles below the water surface regardless of protective system.

Classification: NBE **Units of Measurement:** each

Quantity Calculation: Sum of the number of piles accessible for inspection below the water surface.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched are that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	

Defects	Condition States 1 GOOD	2 FAIR	3 POOR	4 SEVERE
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide Cracks or heavy pattern (map) cracking.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Deterioration (Other) (1220)	None.	Initiated breakdown or deterioration.	Significant deterioration or breakdown but does not warrant structural review.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
Scour (6000)	None.	Exists within tolerable limits or has been arrested with effective countermeasures.	Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This element shall only be included in Underwater Inspections.

The other material pile element is intended for piles constructed of composite materials, or other materials that cannot be classified using any other defined pile element.

8.4.16 Element 890—Submerged Reinforced Concrete Pile Cap/Footing

Description: Reinforced concrete pile caps/footings that are accessible below the water surface during the inspection, including pile caps/footings exposed from erosion or scour. The exposure may be intentional or caused by erosion or scour.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Sum of the length of footings or pile caps accessible below the water surface along the skew angle.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Abrasion/Wear (PSC/RC) (1190)	No abrasion or wearing.	Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Scour (6000)	None.	Exists within tolerable limits or has been arrested with effective countermeasures.	Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This element shall only be included in Underwater Inspections.

The inspector should use judgment when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

8.4.17 Element 891—Submerged Timber Pile Cap/Footing

Description: Timber pile caps/footings that may be placed under one or more piles for element stabilization. This element will be used for evaluation of those portions of timber pile caps/footings under the water surface accessible during the inspection. For all timber pile caps/footings regardless of protective systems.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Sum of the length of the pile cap/footing accessible for inspection measured along the skew angle of the pier or bent.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Decay/Section Loss (1140)	None.	Affects less than 10% of the member section.	Affects 10% or more of the member but does not warrant structural review.	
Check/Shake (1150)	Surface penetration less than 5% of the member thickness regardless of location.	Penetrates 5%–50% of the thickness of the member and not in a tension zone.	Penetrates more than 50% of the thickness of the member or more than 5% of the member thickness in a tension zone. Does not warrant structural review.	
Crack (Timber) (1160)	None.	Crack that has been arrested through effective measures.	Identified crack that is not arrested but does not require structural review.	
Split/Delamination (Timber) (1170)	None.	Length less than the member depth or arrested with effective actions taken to mitigate.	Length equal to or greater than the member depth but does not require structural review.	
Abrasion/Wear (Timber) (1180)	None or no measurable section loss.	Section loss less than 10% of the member thickness.	Section loss 10% or more of member thickness but does not warrant structural review.	

Defects	Condition States 1 GOOD	2 FAIR	3 POOR	4 SEVERE
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Scour (6000)	None.	Exists within tolerable limits or has been arrested with effective countermeasures.	Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This element shall only be included in Underwater Inspections.

8.4.18 Element 910—Reinforced Earth – GRS-IBS Retaining Wall Systems

Description: Reinforced earth constructed retaining wall system used as the structural abutment. The facing for the wall may be concrete block or reinforced concrete precast panels. The caps that support the bearings will be accounted for under the appropriate substructure cap material item.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Sum of the length of the wall inclusive of turnbacks as appropriate. For extended turnback sections adjacent to the bridge measure no further than 50 feet along the wall past the centerline bearing of the abutment.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Split/Spall (Masonry) (1620)	None.	Block or stone has split or spalled with no shifting.	Block or stone has split or spalled with shifting but does not warrant a structural review.	

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Masonry Displacement (1640)	None.	Block or stone has shifted slightly out of alignment.	Block or stone has shifted significantly out of alignment or is missing but does not warrant structural review.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The inspector should use judgment when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

8.4.19 Element 911—Steel Non-Structural Retaining Wall

Description: Steel retaining walls not considered a structural substructure element, including the sheet material retaining the embankment, wingwalls and retaining wall extensions. For all steel retaining walls regardless of protective systems.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Sum of the width of the retaining wall including wingwalls and abutment extensions measured along the skew angle.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None.	Crack that has self-arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack that is not arrested by does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

Wingwalls and retaining wall extensions, shall be considered in the quantity and assessment of the retaining wall element. The retaining wall, any extensions and the wingwalls will be measured at the midpoint of the wall between groundline and the top of the wall.

This element will generally be found as protection for grade beam or pile and cap type structure foundations or as old steel abutments left in place for bank protection

8.4.20 Element 912—Reinforced Concrete Non-Structural Retaining Wall

Description: Reinforced concrete retaining walls not considered a structural substructure element, including the material retaining the embankment, wingwalls and retaining wall extensions. For all reinforced concrete retaining walls regardless of protective systems.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Sum of the width of the retaining wall, wingwalls and retaining wall extensions measured along the skew angle.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Abrasion/Wear (PSC/RC) (1190)	No abrasion or wearing.	Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	

Defects	Condition States 1 GOOD	2 FAIR	3 POOR	4 SEVERE
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

Wingwalls and retaining wall extensions, shall be considered in the quantity and assessment of the retaining wall element. The retaining wall, any extensions and the wingwalls will be measured at the midpoint of the wall between groundline and the top of the wall.

This element will generally be found as protection for grade beam or pile and cap type structure foundations or as old reinforced concrete abutments left in place for bank protection.

The inspector should use judgment when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general, reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.

8.4.21 Element 913—Timber Non-Structural Retaining Wall

Description: Timber retaining walls not considered a structural substructure element, including the timber piling, timber plank or sheet material retaining the embankment, wingwalls, and retaining wall extensions. For all timber retaining walls regardless of protective systems.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Sum of the width of the abutment with wingwalls and retaining wall extensions measured along the new angle.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Decay/Section Loss (1140)	None.	Affects less than 10% of the member section.	Affects 10% or more of the member but does not warrant structural review.	
Check/Shake (1150)	Surface penetration less than 5% of the member thickness regardless of location.	Penetrates 5%–50% of the thickness of the member and not in a tension zone.	Penetrates more than 50% of the thickness of the member or more than 5% of the member thickness in a tension zone. Does not warrant structural review.	
Crack (Timber) (1160)	None.	Crack that has been arrested through effective measures.	Identified crack that is not arrested but does not require structural review.	
Split/Delamination (Timber) (1170)	None.	Length less than the member depth or arrested with effective actions taken to mitigate.	Length equal to or greater than the member depth but does not require structural review.	

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Abrasion/Wear (Timber) (1180)	None or no measurable section loss.	Section loss less than 10% of the member thickness.	Section loss 10% or more of the member thickness but does not warrant structural review.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

Wingwalls and retaining wall extensions, shall be considered in the quantity and assessment of the retaining wall element. Timber piling will not be assessed separately, but as part of the entirety of the retaining wall condition. The retaining wall, any extensions and the wingwalls will be measured at the midpoint of the wall between groundline and the top of the wall.

This element will generally be found as protection for grade beam or pile and cap type structure foundations or as old timber abutments left in place for bank protection.

8.4.22 Element 914—Masonry Non-Structural Retaining Wall

Description: Those retaining walls not considered a structural substructure element constructed of block or stone, including wingwalls and retaining wall extensions. The block or stone may be placed with or without mortar. For all masonry retaining walls regardless of protective systems.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Sum of the width of the retaining wall with wingwalls and retaining wall extensions measured along the skew angle.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Efflorescence/Rust Staining (1120) Patched Area (1080)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Mortar Breakdown (Masonry) (1610)	None.	Cracking or voids in less than 10% of joints.	Cracking or voids in 10% or more of the joints.	
Split/Spall (Masonry) (1620)	None.	Block or stone has split or spalled with no shifting.	Block or stone has split or spalled with shifting but does not warrant a structural review.	
Patched Area (Masonry) (1630)	None.	Sound patch.	Unsound patch.	
Masonry Displacement (1640)	None.	Block or stone has shifted slightly out of alignment.	Block or stone has shifted significantly out of alignment or is missing but does not warrant structural review.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	

Defects	Condition States 1 GOOD	2 FAIR	3 POOR	4 SEVERE
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

Wingwalls and retaining wall extensions, shall be considered in the quantity and assessment of the retaining wall element. The retaining wall, any extensions and the wingwalls will be measured at the midpoint of the wall between groundline and the top of the wall.

This element will generally be found as protection for grade beam or pile and cap type structure foundations or as old masonry abutments left in place for bank protection. Do not use this element for mortared stone bank protection.

8.4.23 Element 915—Other Non-Structural Retaining Wall

Description: Other material retaining wall systems not considered a structural substructure element, including the sheet material retaining the embankment, wingwalls and retaining wall extensions. For all other material retaining walls regardless of protective systems.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Sum of the width of the retaining wall, wingwalls and retaining wall extensions measured along the skew angle.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched are that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	

Defects	Condition States 1 GOOD	2 FAIR	3 POOR	4 SEVERE
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Deterioration (Other) (1220)	None.	Initiated breakdown or deterioration.	Significant deterioration or breakdown but does not warrant structural review.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This element should be used for abutments constructed of materials not otherwise defined.

Wingwalls and retaining wall extensions, shall be considered in the quantity and assessment of the retaining wall element. The retaining wall, any extensions and the wingwalls will be measured at the midpoint of the wall between groundline and the top of the wall.

This element will generally be found as protection for grade beam or pile and cap type structure foundations or as old other material abutments left in place for bank protection.

8.4.24 Element 916—Non-Integral Wingwalls

Description: All wingwalls, regardless of material, that are adjacent to, but not integral with the abutment stems.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Sum of the lengths of all non-integral wingwalls.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Decay/Section Loss (1140)	None.	Affects less than 10% of the member section.	Affects 10% or more of the member but does not warrant structural review.	
Check/Shake (1150)	Surface penetration less than 5% of the member thickness regardless of location.	Penetrates 5%–50% of the thickness of the member and not in a tension zone.	Penetrates more than 50% of the thickness of the member or more than 5% of the member thickness in a tension zone. Does not warrant structural review.	
Crack (Timber) (1160)	None.	Crack that has been arrested through effective measures.	Identified crack that is not arrested but does not require structural review.	

<table>
<tr><th rowspan="3">Defects</th><th colspan="4">Condition States</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><th>GOOD</th><th>FAIR</th><th>POOR</th><th>SEVERE</th></tr>
<tr><td>Split/Delamination (Timber) (1170)</td><td>None.</td><td>Length less than the member depth or arrested with effective actions taken to mitigate.</td><td>Length equal to or greater than the member depth but does not require structural review.</td><td rowspan="2">The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.</td></tr>
<tr><td>Abrasion/Wear (Timber) (1180)</td><td>None or no measurable section loss.</td><td>Section loss less than 10% of the member thickness.</td><td>Section loss 10% or more of the member thickness but does not warrant structural review.</td></tr>
<tr><td>Settlement (4000)</td><td>None.</td><td>Exists within tolerable limits or arrested with no observed structural distress.</td><td>Exceeds tolerable limits but does not warrant structural review.</td><td></td></tr>
<tr><td>Damage (7000)</td><td>Not applicable.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.</td><td>The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.</td></tr>
</table>

Element Commentary

All wingwalls, regardless of material, that are adjacent to, but not integral with the abutment stems.

Generally, for wingwalls to be considered to be non-integral, there must be an open expansion joint between the abutment stem and wingwall(s). In the case of timber, wingwalls are considered non-integral if the wingwalls are splayed (not in the same plane as the abutment stem face) and/or do not share common backwall planks for cap planks.

Note that the above table is what is currently in the BrM and consists of timber defects; however, this table may be expanded in a future edition of this BIM.

8.5 Channel ADEs

8.5.1 Element 900—Bridge Scour

Description: This element is to track scour distresses which are evident during visual inspections. The primary purpose is to identify bridges that are experiencing scour and to provide some measure of the magnitude of scour. This element may be used as a substructure sub-element and used in support of the scour defect (6000).

Classification: ADE **Units of Measurement:** each

Quantity Calculation: Sum of the number of substructure units affected by scour.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Scour (6000)	None.	Exists within tolerable limits or has been arrested with effective countermeasures.	Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.

Element Commentary

None.

8.5.2 Element 901—Scour Countermeasures

Description: Substructure protection devices or systems installed to mitigate scour problems. This element is not for tracking typical bank protection placed during bridge construction.

Classification: ADE **Units of Measurement**: each

Quantity Calculation: Sum of the number of countermeasure protected elements or protection systems.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Settlement (4000)	None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Scour (6000)	None.	Exists within tolerable limits or has been arrested with effective countermeasures.	Exceeds tolerable limits but is less than the critical limits determined by scour evaluation and does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	

Element Commentary

None.

8.6 Off-Bridge ADEs

8.6.1 Element 950—Steel Approach Guardrail

Description: All types and shapes of metal approach railing. Steel, aluminum, metal beam, rolled shapes, etc. will all be considered part of this element. Included in this element are posts of metal, timber, or concrete; blocking; and curb.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Measured length of metal approach rail including the transition section, but exclusive of the end 50' at each approach rail (this 50' is covered under Element 960). The element quantity includes only the approach rail between the bridge and the end 50' section. For approach guardrail that is longer than 150', only access the first 100' from the end of the bridge rail.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None.	Crack that has self-arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4

		under the appropriate material defect entry.	under the appropriate material defect entry.	under the appropriate material defect entry.

Element Commentary

The approach rail will generally be located on all four corners of a bridge on two lane roads and at least the approach ends of the bridge rail on one or multiple lane, one-way roadways. If the roadway is multiple lanes in each direction separated by a median rail other than metal, just record the metal rail under this element and the different material median rail under the appropriate element. Refer to the other approach rail material elements (concrete, timber, masonry, other) for specific defects for assessing the condition of posts, blocking, and curbs that may be constructed of materials other than metal.

8.6.2 Element 951—Reinforced Concrete Bridge Approach Railing

Description: All types and shapes of reinforced concrete approach railing including transition sections. All elements of the railing must be concrete.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Measured length of metal approach rail including the transition section, but exclusive of the end 50' at each approach rail (this 50' is covered under Element 960). The element quantity includes only the approach rail between the bridge and the end 50' section. For approach guardrail that is longer than 150', only access the first 100' from the end of the bridge rail.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None.	Present without measurable section loss.	Present with measurable section loss but does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The approach rail will generally be located on all four corners of a bridge on two lane roads and at least the approach ends of the bridge rail on one or multiple lane, one-way roadways. If the roadway is multiple lanes in each direction separated by a median rail other than reinforced concrete, just record the concrete rail under this element and the different material median rail under the appropriate element. Refer to the other approach rail material elements (steel, timber, masonry, other) for specific defects for assessing the condition of posts, blocking, and curbs that may be constructed of materials other than reinforced concrete.

8.6.3 Element 952—Timber Approach Railing

Description: All types and shapes of timber approach railing. Included in this element are posts of timber, blocking, and curb.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Measured length of metal approach rail including the transition section, but exclusive of the end 50' at each approach rail (this 50' is covered under Element 960). The element quantity includes only the approach rail between the bridge and the end 50' section. For approach guardrail that is longer than 150', only access the first 100' from the end of the bridge rail.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Decay/Section Loss (1140)	None.	Affects less than 10% of the member section.	Affects 10% or more of the member, but does not warrant structural review.	
Check/Shake (1150)	Surface penetration less than 5% of the member thickness regardless of location.	Penetrates 5%–50% of the thickness of the member and not in a tension zone.	Penetrates more than 50% of the thickness of the member or more than 5% of the member thickness in a tension zone. Does not warrant structural review.	
Crack (Timber) (1160)	None.	Crack that has been arrested through effective measures.	Identified crack that is not arrested but does not require structural review.	
Split/Delamination (Timber) (1170)	None.	Length less than the member depth or arrested with effective actions taken to mitigate.	Length equal to or greater than the member depth but does not require structural review.	

Defects	Condition States 1 GOOD	2 FAIR	3 POOR	4 SEVERE
Abrasion/Wear (Timber) (1180)	None or no measurable section loss.	Section loss less than 10% of the member thickness.	Section loss 10% or more of the member thickness but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

The approach rail will generally be located on all four corners of a bridge on two lane roads. Timber rail is generally not found on larger multi lane roadways. Refer to the other bridge rail material elements (metal, concrete, masonry, other) for specific defects for assessing the condition of posts, blocking, and curbs that may be constructed of materials other than timber.

8.6.4 Element 953—Other Approach Railing

Description: All types and shapes of approach railing including transitions except those defined as metal, concrete, or timber.

Classification: ADE **Units of Measurement:** ft

Quantity Calculation: Measured length of metal approach rail including the transition section, but exclusive of the end 50’ at each approach rail (this 50’ is covered under Element 960). The element quantity includes only the approach rail between the bridge and the end 50’ section. For approach guardrail that is longer than 150’, only access the first 100’ from the end of the bridge rail.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Corrosion (1000)	None.	Freckled rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Cracking (1010)	None.	Crack that has self-arrested or has been arrested with effective arrest hole, doubling plates, or similar.	Identified crack that is not arrested but does not warrant structural review.	
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant structural review.	
Delamination/Spall/ Patched Area (1080)	None.	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched are that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	
Efflorescence/Rust Staining (1120)	None.	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	

Defects	Condition States 1 GOOD	2 FAIR	3 POOR	4 SEVERE
Cracking (RC and Other) (1130)	Insignificant cracks or moderate-width cracks that have been sealed.	Unsealed moderate-width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Deterioration (Other) (1220)	None.	Initiated breakdown or deterioration.	Significant deterioration or breakdown but does not warrant structural review.	
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

This element should be used for materials not otherwise defined. The approach rail will generally be located on all four corners of a bridge on two lane roads and at least the approach ends of the bridge rail on one or multiple lane, one-way roadways. If the roadway is multiple lanes in each direction separated by a median rail of a defined material, just record the other rail under this element and the different material median rail under the appropriate element. Other material rail used for the protection of pedestrians will only be included if it is attached to a bridge rail element.

8.6.5 Element 960— Steel Approach Guardrail Ends

Description: All types and shapes of approach rail end treatments.

Classification: ADE **Units of Measurement:** each

Quantity Calculation: Number of guardrail end treatments on the approach rail off of the bridge.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Connection (1020)	Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Distortion (1900)	None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	
Damage (7000)	Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in Condition State 4 under the appropriate material defect entry.

Element Commentary

Only three defects will be available for this element.

8.6.6 Element 965—Approach Roadway

Description: Approach roadway adjacent to the bridge

Classification: ADE **Units of Measurement:** each

Quantity Calculation: One unit for each bridge end.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Bump/Bounce	No noticeable bump/bounce	Minor bump onto bridge.	Rough ride with significant bumps	There is danger of a vehicle losing control as it moves onto the bridge at the posted speed.

Element Commentary

This element is intended to track the effect the approach roadway has on impact to the bridge deck.

8.6.7 Element 970—Erosion

Description: Loss of fill material due to water (runoff) erosion around and under the bridge.

Classification: ADE

Units of Measurement: each

Quantity Calculation: One for each bridge end.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Erosion	No defects	Minor erosion along roadway edges. Beginning to affect the roadway shoulders.	Moderate erosion. Affecting the approach guardrail supports.	Major erosion. Undermining of the approach roadway in travelways. Visible settlement in roadway due to erosion.

Element Commentary

This element is intended to track erosion that may pose a danger to the traveling public. It is not intended to track issues that affect the structural integrity of the bridge itself.

8.6.8 Element 971—Loss of Roadway Fill

Description: Loss of fill material due to material sloughing out from under the abutments.

Classification: ADE **Units of Measurement:** each

Quantity Calculation: One for each abutment.

Condition State Definitions

	Condition States			
	1	2	3	4
Defects	GOOD	FAIR	POOR	SEVERE
Loss of material	No defects or countermeasures have been added to stop loss of material.	Minor amount of material loss without any effect on the approach roadway.	Moderate amount of material loss. Approach roadway embankment may show minor settlement or small voids.	Major amount of material loss. Visible roadway settlement or large voids under the roadway embankment.

Element Commentary

This element is intended to track loss of roadway material that may pose a danger to the traveling public. It is not intended to track issues that affect the structural integrity of the bridge itself. It is primarily intended to be used for spill-through abutments and timber abutments where the bottom planks are high enough to allow roadway fill to slough out from under them.

Material lost through these types of abutments may or may not be visible under the bridge. In some cases, it may be washed away by the water under the bridge.

Chapter 9 – Record Keeping and Documentation

Chapter 9 provides guidance for pre-inspection bridge review, defect note-taking, photo documentation and uploading correspondence and bridge-related documents to BrM. This discussion is followed by guidance for inspection report draft generation in BrM, QC review of the inspection report draft, finalization of the inspection reports, reporting requirements for significant changes or problems discovered, and guidance for adding repair suggestions. Chapter 9 also has an appendix, which includes a field inspection checklist.

9.1 Photo Requirements

A minimum of three photos are required for each inspection: approach, profile, and the underside of a bridge or inside of the barrel for culverts. If a bridge is over a waterway looking upstream, and looking downstream photos are also required. Additional photos are required when deterioration or a defect is found in accordance with Chapter 3 requirements. Include clear photos of any signed weight restrictions or clearance posting signs at the bridge. If a photograph of the posting sign does not provide a close enough view of the bridge approach, provide an additional photo of the approach.

9.2 Pre-Inspection Review

Prior to the on-site inspection, become familiar with the design(s), material(s), work history, related correspondence, and status of the structure. Review all previous inspection reports and bridge related documents (e.g., plans, load rating, correspondence, scour, etc.) in the BrM Multimedia tab in addition to any previous testing and monitoring results, maintenance and repair records, and accident or damage history. This will alert the inspector to any special inspection equipment needs, problem elements to give extra attention, or the need for an expanded inspection type that may not have been scheduled such as Nonredundant Steel Tension Member, Underwater, or Pin and Hanger.

During this review, it is the Team Leader's responsibility to develop new or modify an existing general inspection plan including the use or modification of previously developed NSTM and underwater inspection plans, as necessary. These plans are to include assigning inspection responsibilities to appropriate team members and how the effective, efficient, and safe inspection of all bridge elements will be carried out. The inspection plan must consider the extent of the traffic control required at the bridge site, coordination of traffic control with MDT Maintenance personnel, any necessary coordination with railroad personnel, and any special equipment required to carry out the inspection.

9.3 Inspection Methodologies

Inspections are performed using two distinct inspection methodologies. The Element inspection concentrates on the bridge elements and the deterioration of the discrete components broken out from the superstructure, substructure, and deck. The SNBI inspection concentrates on the overall condition assessment of the structure and how the structure functions in its environment.

9.3.1 Note-Taking, Narrative Fields, and Correspondence

Whenever a CS-3 or CS-4 condition exists for any element, include, at a minimum, one narrative comment and at least one photo. See sections 5.5 through 5.10 for other related procedures and requirements. Use bullets when practical to organize narrative field notes in BrM.

Upload all bridge-related documents and associated correspondence to the Multimedia tab of BrM for Critical Findings, Hydraulics Inspection Procedures, Load Posting, Load Ratings, Plans, Shop Drawings, Measurement Forms, and Work Candidates. Print all document types to PDF before uploading to BrM. However, if spreadsheets are intended to be used in subsequent inspection for tracking measurement or notes of specific items being monitored, upload these in XLSX format. Conversely, if any spreadsheet is a single-use document not intended for future inspectors, print it to PDF before uploading. In summary, any document intended to be permanent and not to be changed by another user must be uploaded to BrM in PDF format.

9.3.2 Post-Inspection and BrM Reporting and Review Procedures

A complete and accurate inspection report is essential for each bridge inspection performed to provide specific details about the bridge and its current condition. Standard report forms have been developed for SNBI and element-level inspections that provide a means of recording standard information pertinent to all bridges and other information unique to each particular bridge.

Enter and upload all inspection data gathered during the site inspection to BrM. Verify that the appropriate bridge elements are used, their total quantity is correct, and that field notes make it into the proper areas (i.e., element, defect, general, etc.) of the reports. Also, all NBI/MDT items coding must be entered or verified and necessary Work Candidates (a.k.a. Repair Suggestions) generated (See Section 9.3.4 for guidance). Review the Component Condition and Element Condition States that are required for the specific Inspection Type performed.

Condition codes and States must be reviewed and updated for all inspection types: Routine, NSTM, Special, UW, Follow Up, and Other, as applicable for required components and elements. Document changes made to the required codes or states. Review related procedures and POAs, and update conditions and codes when applicable. The Team Leader is required to perform quality control of the report in accordance with Appendix 10A – Inspection Report Review Checklist prior to approving and e-signing the inspection in BrM.

When performing an inspection of a new or rehabilitated structure, perform a full inventory of all element-level data and revise all NBI and MDT fields, as necessary. Following an initial inspection, BrM will retain all inventory, assessment, and condition information for future use and reference, including but not limited to the element designation, total quantity, and percentage in each condition state for all elements, work items, inspection ratings for the field inspected NBI items, and values entered for all MDT fields.

Place field notes and descriptions in the proper section of the inspection report (i.e., element or defect notes with the corresponding element or defect, and SNBI notes in each item’s comments box). These notes need to be clear and detailed enough to accurately convey the bridge's characteristics and condition data to engineers, load raters, future inspectors, county bridge owners, and the public. Specifically, use notes and descriptions for all defects that allow for a thorough understanding by the Load Rating Engineer, enabling an accurate update to the load rating, when necessary. Detailed inspection and documentation requirements are covered in Chapter 3.

All completed inspections are subject to the following QC process. The Inspector will forward the completed the inspection report to an independent Reviewer that meets Team Leader qualifications. Responsibilities of the reviewer include checking the inspection report for completeness, accuracy, and compliance with MDT/FHWA standards. The Reviewer is required to complete an Inspection Report Review Checklist in the Inspection Review Module in BrM prior to sending the report back to the

Inspector by sending it back to the previous step in the review module. Next, the Inspector will address any Reviewer comments and submit the report to the next step in the review module, sending it back to the Reviewer. Once the Reviewer is satisfied that all comments have been properly addressed, the report is submitted to the next step, automatically generated, and the inspection is considered complete. Certain Inspections are also selected for Contract Administration Review, which is an additional review step following the same review process in the BrM Review module.

Inspectors are required to finalize SNBI/Element bridge inspection data in the database by the 28th day of the next month after the bridge was inspected. Inspectors must complete data verification and review within 90 days of the inspection date. Note that if inspection data is not created from the assignment in BrM before the bridge is due for inspection, the bridge will show up on the late inspection list. All bridges are to be inspected on or before their due date. The due date is the end of the calendar month of the proposed inspection date.

Reporting Significant Changes or Problems

Special reporting is required whenever a significant change or problem is noted. A significant change or problem is any issue that involves structural concerns from deterioration or damage, or issues or concerns that impact the safety of the traveling public. Structural concerns are issues or defects that may require re-rating the bridge, missing or damaged load limit or clearance posting signs, significant scour, or a significant change in condition state ratings. Safety concerns include items or issues that affect the safety of pedestrians or vehicular hazards such as loose joint headers, bridge rail damage, minor approach roadway settlement, missing object markers etc. The bridge structural and safety concerns in this category are considered just below the threshold for critical findings. Inspectors are required to request a load rating review using MDT034 when a structural defect or condition is discovered or deteriorates to a point that is suspected to affect the load carrying capacity of the structure. A call, text, or email notification and BrM upload is required within 24 hours.

Report issues on State-maintained bridges to the Area Bridge Inspection Manager, the Maintenance Chief, and others as appropriate. The Work Candidates listed in BrM may suffice for a part of this notification.

Report issues with non-State-maintained bridges to the bridge's owner and the Area Bridge Inspection Manager. Verbally notify the Owner as soon as is reasonable after the inspection. These issues must be specifically included in BrM.

9.3.3 Adding Work Candidates in BrM

9.3.3.1 Intent

Work Candidates placed in BrM should be limited to maintenance-level type activities. They are intended to be used by MDT Maintenance and County maintenance forces, so they can quickly and easily find and prioritize necessary maintenance level repairs. The Work Candidates included should be able to be completed by Maintenance personnel, with or without the assistance of the Bridge Maintenance Engineer or County Engineers. They should also be actions that can be completed and closed out, i.e. – "Monitor element for…" is *not* an appropriate Work Candidate.

Work Candidates in BrM are *NOT* intended to be used by designers and engineers for querying Federal Aid project level repair and rehab activities. Rather, Federal Aid project developers (engineers, designers, and consultants) determine the scope of bridge rehabilitation and replacement activities by querying general bridge and element-level conditions. Although engineers and developers will include Work Candidates that have been entered into BrM in Federal Aid rehab projects, they are not used in initial project development.

9.3.3.2 Examples of Work Candidates to Include in BrM:

- Object marker repair/replace
- Approach Guardrail repairs
- Potholes/deck spalls
- Missing bolts
- Loose nuts
- Clean debris out of deck drains
- Reset Elastomeric bearings
- Repairs to rotten, deteriorated, or shifted Timber elements (cap, piles, decks, girders, rails, etc.)
- Loose steel joints or guard angles (sliding plates and other embedded type joints and headers that pose a safety hazard when they come out)
- Repair impact damage (rails, posts, prestress or steel beams, etc.)
- Remove channel debris on piers/abutments
- Cracks in steel members (these may or may not be critical; may require an immediate call to Headquarters)
- Clean debris out of joints
- Clean debris off caps/bearings
- Remove vegetation or clear trees that prevent inspection of bridge elements, grow within the shadow of the bridge, restrict travelers' visibility, or could fall and damage the bridge
- Wingwall/backwall issues (including erosion under or around the wingwall)
- Approach roadway settlement or side slope erosion near the bridge
- Scour or erosion issues that can be mitigated with small scale operation to place rip-rap. These would typically be small, county-owned structures (but possibly State-owned) on small streams or washes.

9.3.3.3 Examples of Work Candidates *NOT* to Include in BrM:

- Scour Issues that are on large bridges over large waterways that require hydraulic engineering and a major project to mitigate.
- Deck seal or deck overlay
- "Monitor…"
    - Do not recommend a bridge or element to be "monitored." If necessary, an accelerated inspection interval is the proper procedure.
- Larger repair items that Maintenance does not have the resources to complete

There are many gray areas, so please do not be afraid to call Headquarters and ask if something specific is appropriate to be included as a Work Candidate in BrM.

9.3.3.4 Procedures for Inputting Work Candidates:

Here are some basic guidelines to follow when inputting Work Candidates. Under the "WORK" tab in BrM, select "WORK CANDIDATES." Click the "Add New" box. This will take you to the work page for entering a new Work Candidate.

- ACTION TYPE:
    - Designate the action type from the drop-down box. This presents options for the general area that the action will apply (Deck, Joints, Scour, Superstructure, Substructure, Timber, etc.). This action type filters actions to make it easier to select an action.
- ACTION:
    - The options in the Action tab are dependent on the Action Type selected. For example, if "Deck" was selected as an Action Type, the options presented in the Action drop down are specific to deck repairs: Class A, Class B, Drains, deck overlay, approach slab, etc.
- DATE RECOMMENDED:
    - Enter the date of the recommendation. This will usually correspond with the inspection date unless it is a special inspection of some type.
- PRIORITY:
    - Designate the Work Candidate as Low, Medium, or High priority.
    - Base this on your judgment and the level of structural risk associated with it, or if it presents an immediate or imminent safety hazard, designate it as high.
    - Low Priority examples: clean joints, repair curb, repair cap spall, etc.
    - High Priority examples: Repair rotten timber cap, repair loose sliding plate joint, remove debris on pier, etc.
    - When you feel the issue needs an urgent review from someone in Headquarters, or the item may be Critical, contact Bridge Management directly and immediately. (See Chapter 5 for Critical Finding guidance.)
- STATUS:
    - All new Work Candidates input into BrM should be designated as "Repair Suggestion."
    - If you notice during an inspection or are notified by the County or MDT Maintenance that an item has been completed, change the Status to "Work Complete." This also triggers or requires the following to satisfy the 90 Post Rehab Inspection requirement:
        - In the Comments section, add a quick description of the work done, who did the work (or who notified you), and when it was done (or when you noticed it was complete).
    - Any documents, repair details, or correspondence that you feel are relevant should be put in the documents tab of the repair.
- COMMENTS:
    - Include a one- or two-sentence description of the repair issue. Include a description of the location (specific span, bent, pile, joint, etc.).

Chapter 9 Appendices

Appendix 9A
Climbing Bridge Inspection Full Report Guidance
(Removed 4/2026)

Appendix 9B
Field Inspection Checklist

Field Inspection Checklist

Bridge No.___________

General:

_____ Bridge is labeled correctly, following the labeling priorities in MDT's guidance.
_____ Reviewed the entire latest report before inspection *and* before leaving site (all previous notes addressed)?
_____ TL/Assistant discussed any issues before leaving the field (especially if working independently)?
_____ All required general/condition photos were taken, including work items, repaired items & CS3-CS4 conditions?

Work items and Significant Changes to NBI Ratings:

_____ Notified the area manager about any critical or significant findings at the time of inspection? Photos taken?
(Examples: Cracks in main members, failing members, missing posting signs, vehicular/pedestrian hazards)

_____ Previous work items were updated where applicable (do not create redundant items)?
_____ Notified area manager about possibly lowering main NBI item condition rating(s) by more than 1 (Items B.C.01, B.C.02, B.C.03, B.C.04, B.C.09 - B.C.11, B.C.14, B.C.15)?

Signage and posting:

_____ Were clearance forms completed?
_____ Were discrepancies in vertical/lateral clearances double-checked (Items B.H.12, B.H.13, B.H.14, B.H.15, B.H.16, B.RR.02, B.RR.03)?
_____ Is vertical clearance posting required (<16' over Interstates or <15' over other routes)
____ At-bridge and advance signs are in place? ____ Defects noted? _____ Photos taken?
_____ Load posting signs in place if required?
____ At-bridge and advance signs are in place? ____ Defects noted? _____ Photos taken?
_____ Object marker defects are noted in the report? ____ Photos taken?
_____ Speed limit posting sign near bridge (__ MPH).

Deck/Approaches:

_____ Average curb reveals/ballast depth were measured (when possible)?
_____ Excluded Element 950 (Guardrails) at corners <50' long? (End 50' is covered at Element 960).

Superstructure:

_____ Section loss sketches were generated for losses difficult to describe with words?
_____ Do all losses have 3 dimensions and location from a fixed point?
_____ Are section loss notes detailed enough to update a load rating?
_____ Spot checked original sizes in field and checked for tapered flanges in the event of section losses?
_____ Measured length of the sole plate and web overhang behind the bearing for buckling section loss calculations?

Substructure:

_____ Exposed footings have 3 dimensions (i.e., exposed up to 10" high x 6' long x up to full width across top)?
_____ Is there any tipping/settlement? Global bearing over-contraction/expansion may be a clue there's settlement.
    ____ Used a level or plumb bob to measure tipping?
_____ Boring Inspections:
    ____ Located the limits of rot in the caps (end section loss measurement less than 10%)
    ____ Section loss percentages are given or can be computed in the office from field measurements?

Channel:

- Probe and Wade Inspections:

____ Included comments in the general notes section of BrM for channel deficiencies? Required if Item B.C.09 or B.C.10 is < 7.
____ Were channel measurements taken at the upstream fascia?
____ Was the Probe and Wade section of the Appraisal tab filled out in BrM?

- For structures with Underwater Inspections on a different cycle than the biennial:

____ Were the previous underwater inspection channel notes reviewed?
____ Were any additional defects evident at the biennial inspection noted?

Miscellaneous:

_____ Measurement forms were completed for bridges with missing or outdated plans/measurement forms?
_____ Geometric coding items were spot-checked in the field to ensure plans/measurements forms are current?
_____ NBE original quantities were spot-checked in the field?
    ____ Followed coding for proper original quantity for sistered girders/stringers?
    ____ Verified integral versus non-integral wings? Use Element 916 for ALL wings, regardless of material.

____ Mat bearing original quantity should be coded as # of contact points.

____ Ignored bearings that are more than 50% encased in the NBE quantity?

____ Followed proper use of columns versus piles for NBE selection (piles are driven, columns are not)?

____ Updated NBE qtys, as req'd, if new measurement forms were created or existing forms were updated?

_____ Total of CSs for individual defects does not exceed 100% (i.e., Abut Cracking CS-1+CS-2+CS-3+CS-4 $\leq$ 100%)?

_____ Overlapping defects were included and rolled up properly?

_____ Utility defects are noted in General Notes section of BrM?

Chapter 10 – Review and Quality Assurance

Chapter 10 outlines responsibilities and requirements for Quality Control/Quality Assurance performed by Areas and by the Bridge Management Section in Headquarters. Space is reserved in this section for an updated Quality Assurance Program to be added at a later date.

10.1 Quality Control/Quality Assurance

Metric 20 requirement: Systematic quality control (QC) and quality assurance (QA) procedures are used to maintain a high degree of accuracy and consistency in the inspection program.

QC/QA procedures include periodic field review of inspection teams, periodic refresher training requirements, and independent review of inspection reports and computations.

The Quality Control/Quality Assurance processes are a vital part of the Bridge Inspection Program. MDT requires a high level of data integrity to meet its needs and responsibilities. Quality Control is an Area function. Quality Assurance is a function of the Bridge Management Section in Headquarters.

10.1.1Quality Control (by Areas)

Quality Control refers to the steps each Area takes to monitor the accuracy of inspections and confirm that data collection is complete. Proper Quality Control will ensure the inspection data gathered is consistent and meets the guidelines established by MDT.

The Area Bridge Inspection Manager is responsible for administering the Area Quality Control plan. The quality control plan may be customized to fit the Area's procedures but must include the following minimum items.

<u>Data Verification</u>

A second-party reviewer who meets the qualification of Team Leader will review each inspection report. This person should not have been involved in performing the inspection and will review the report for accuracy, completeness, consistency, and the reasonableness of the inspection. Any errors noted or problems identified will be addressed with the individual who performed the inspection. If the issues cannot be resolved, the discussion may be elevated to the Bridge Management Section.

<u>On-Time Inspections and Reporting</u>

Ensure that bridge inspections are performed within the required intervals and that inspection data is entered and reviewed within the specified time.

<u>Rotation of Inspectors</u>

Each year, the Area will rotate a minimum of 10% of its bridges to another inspector in that Area. These bridges must include a variety of bridge types with a diverse combination of materials and design types. When significant differences are identified from one inspector to the next, the inspectors will schedule a meeting and discuss the differences.

<u>Element Spot Check</u>

Each year, the Area Bridge Inspection Manager will randomly choose 5% of the Area's bridges to review. These structures must include a diverse combination of material and design types. This review will assess the accuracy and completeness of the inspection. Data review will include element identification, environmental state, quantities, condition states, and all NBI and non-NBI fields for which the inspectors are responsible. The Manager will also review consistency from inspection to inspection and throughout the Area. Spot checks are an ongoing process that occurs throughout the year.

Internal Quality Assurance

Area-level Quality Assurance is a check on the administration and operation of the Quality Control plan. Area Quality Assurance is performed on a semi-annual to annual basis. Upon completion of the review, a compliance report is prepared that describes areas of conformity and non-conformity, as well as any corrective actions taken. The report is sent to the Bridge Inspection Engineer, and the Area Bridge Inspection Manager retains a copy on file. These are intended to be learning opportunities in an ongoing process improvement.

10.1.2 Quality Assurance (by Bridge Management Section, Headquarters)

The purpose of the quality assurance review program is to evaluate program effectiveness, uniformity, and compliance with federal and state rules relating to bridge inspections. Quality assurance reviews may recommend program improvements and may require changes in a program. Inspector training is an integral part of the quality assurance process and helps ensure uniformity of inspections throughout the state. The quality assurance review program, under the direction of the Bridge Management Section, involves two different levels of review: office review and field review.

Office Review

An office review consists of reviewing information such as inspection reports and bridge measurements submitted to the Bridge Management Section. These reviews occur on a random sample of at least 5% of inspections as inspection data arrives in the Bridge Management Section.

Field Review

The Bridge Management Section personnel or QA Consultants will conduct a quality assurance inspection review of NBI/Element inspections performed by each Area. Every year, a random sample of SNBI/Element inspections will be reviewed for consistency and conformance with State and Federal policy and procedures. The Bridge Management Section or QA Consultants will perform a yearly field review on the NBI/Element inspections of at least 2% of each Area's bridges.

The Area Bridge Inspection Manager, Team Leaders, and at least one of the Bridge Management Section's Bridge Inspection Engineer and Bridge Inspection QA engineer or QA Consultants are required for review team members. Other inspection personnel from the Area being reviewed should also attend. Bridge Inspection staff from other Areas may rotate onto the team, as well as any new Bridge Management Section staff. Bridge design personnel are encouraged to participate in the Quality Assurance Review process as guest inspectors.

The quality assurance team will generate an independent inspection report for those bridges selected. The team will then compare their inspection report to the latest inspection reports and information. The accuracy of the condition ratings and the comments are reviewed to ensure they reflect the actual conditions of the bridge. Discrepancies are documented and discussed with the bridge inspector.

On-site inspector training is provided during these reviews as training needs are identified. The Bridge Management Section conducts this training and will tailor the training to the needs of each Area. Training needs are identified through the Office Review process and on previous Field Reviews.

Internal Quality Control

Bridge Management Section personnel or QA Consultants will check for errors as they work and coordinate updates to BrM with the Team Leaders. At the end of each Quality Assurance Field Review, the engineers involved in the review will go through the file for each bridge reviewed to make sure all relevant information is in the file and to remove any duplicate information.

10.2 Quality Assurance Program (Reserved)

Reserved.

10.3 Field Inspection - QC/QA (Reserved)

Reserved.

Chapter 10 Appendix

Appendix 10A
Inspection Report Review Checklist

Inspection Report Review Checklist

Bridge No.______________

General:

____ Bridge is labeled correctly, following the labeling priorities in MDT's guidance.
____ All field personnel are included in BrM?
____ Inspection dates and future dates are correct?
____ Follow-up inspection required/scheduled for excessive snow, etc.?
____ Clearance coding matches clearance diagram or clearance measurement form?
    ____ Vertical clearance is above 16' over interstates or above 15' over other routes?
    ____ Vertical clearance posting signs in place, if req'd? Posting sign deficiencies are noted in report?
____ Load posting signs are in place if required? Any deficiencies are noted in report?
____ Object markers are in place? Any deficiencies are noted in the report?
____ Did inspector generate new measurement forms due to missing or outdated plans/measurement forms?
____ Geometric coding items match plans and/or measurement forms?
____ Did the inspector lower any major NBI item ratings by more than 1 (B.C.01 - B.C.04, B.C.09 - B.C.11, and B.C.14 - B.C.15)?
____ Does reviewer feel any major NBI item rating should be reduced by more than 1?

Channel:

____ Probe/Wade channel notes are included in general notes section of the report, if B.C.09 or B.C.10 < 7?
____ Probe and wade procedures/measurements completed?
____ Was the Probe and Wade section of the Appraisal tab filled out in BrM?
____ For bridges with underwater inspections (previous Type 2), is there a scour appraisal on file?
____ Was UW report referenced? Are there other defects evident during this off-cycle insp?

Work Items & Serious/Critical Findings:

____ Work items were reviewed after the entire report was completely reviewed?
____ Previous work items were updated, if needed.
____ Were redundant work items generated for previously open items? If so, remove.
____ Were any critical or serious findings reported by the inspector? Were protocols followed?
____ Does reviewer feel there are any other conditions that might be critical or serious findings?

NBE, General:

____ General photos included (profile, bridge from approach, underside, upstream downstream)?
____ Section loss sketches are included for losses difficult to describe with words?
____ Inspection defect notes coincide with correct condition state?
____ Defects have dimensions and locations (not just stating CS-2 checks, etc.)?
____ Total of CSs for individual defects does not exceed 100%?

_____ Overlapping defects included and rolled up properly?
_____ Previous defects were addressed in current report? Repairs noted if any?
_____ Photos included for CS-3 & CS-4 defects?
_____ Proper photo documentation procedures were followed?

Other NBE Items:

____ Added wearing surface (paved width x structure length)?
____ Protective Coating:
    ____ Gen: Used only Effectiveness Defect Code for painted or galvanized elements?
    ____ Gen: Used Oxide Film Defect Code for weathering steel if patina formed?
    ____ Railings: Used railing cheat sheet for railing protective coating original quantity?
____ Bearings: Entire bearing should only be in one CS for each defect and paint/protective coating.
____ If new measurement forms were created or updated, were the NBE original quantities updated?